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DESCRIPTION OF NEW CARNIVORES FROM THE MIOCENE OF WESTERN NEBRASKA.

BY O. A. PETERSON.

While prospecting in the layer of fossil bones, which is exposed around "Carnegie Hill" and "University Hill" in the Miocene formation on the upper Niobrara River in Sioux County, Nebraska, with a view to opening additional quarries,[1] the writer, assisted by Messrs. T. F. Olcott and A. A. Dodd, was extremely fortunate in finding in what is now called Quarry No. 3 (see Fig. 1, 3) various

FIG. 1. Agate Spring Fossil Quarries. 1–2, quarries Nos. 1 and 2, on Carnegie Hill; 3, quarry No. 3; AM, American Museum quarry on Carnegie Hill; NU, Nebraska State University quarry on University Hill; A, quarry A. (From a photograph by the author.)

remains of carnivora, among which is a nearly complete skeleton of a canid. The material having been entirely freed from the matrix and prepared for mounting by the skillful work of Mr. S. Agostini, the writer was entrusted by Director W. J. Holland with the task of describing and illustrating the new material.

[1] No quarries except quarry A had at that time (1904) been opened in these hills.

In the quarry designated as No. 3 in the accompanying illustration, there were found from five to nine individuals of *Daphœnodon superbus*, of which No. 1589 is practically a complete skeleton. The latter was found imbedded together with another individual of the same species not fully adult. The soft sandstone in which the two were found was taken out in a large block and transported to the Museum. On examination it was found that the adult individual was partly articulated, especially the vertebral column and portions of the feet. The tail was found attached to the sacrum and thrown backward in a graceful curve so that the tip was lying close to the pelvis and abdominal region. The anterior nine vertebræ and the anterior portion of the tenth were preserved in position. At this point the caudal region had been exposed and the vertebræ had dropped out. By carefully measuring the natural curve, in which the tail was undoubtedly placed, its length was ascertained and the missing vertebræ were either restored in plaster, or by other vertebræ which were found in the talus below the place where the skeletons were dug out. The ribs of No. 1589 are not well preserved while those of the younger individual, No. 1589a, are quite complete. The posterior portion of the sternum is not present. One hind limb and foot of No. 1589 was found articulated.

The posterior portion of the pelvis is weathered away, as is also the extreme anterior portion, leaving only the middle region. When material other than the type is used in the following description it is only for the purpose of elucidation and the catalog number will be mentioned in connection with the specimens referred to in order to prevent confusion.

Scattered remains of a number of individuals, apparently of the same species, were found in all of the Agate Spring Fossil Quarries, but in Quarry No. 3 were found the most abundant remains of *Daphœnodon superbus*. Besides the type of *Nothocyon annectens* Peterson and another small carnivore described later in this paper there was little else found in Quarry No. 3 except remains of *Daphœnodon superbus*. This is interesting from the fact that hardly more than a stone's throw to the north and practically on the same level, the very rich and classic quarries, No. 1, No. 2, and the "University Quarry" are located (see Fig. 1). The lithological characters of the bone layer of Quarry No. 3 are similar to those in the large quarries and it was observed that the same barren pinkish bedrock found in the main quarries is also present in this quarry. The irregularity of the fossil-bearing stratum was observed to be quite like that in the quarries immediately to the north. As has been stated elsewhere, the stratum containing fossil bones in the Agate Spring Fossil quarries was most probably laid down by a stream full of shallow channels which shifted from time to time during its existence.

Much field-work has been done and a considerable amount of material representing the carnivora has been found in the lower and middle Miocene of South Dakota, western Nebraska, eastern Colorado and Wyoming during the past few years by the different museums of North America.[2] Since further explorations of this region are likely to occur in the near future it has seemed best to postpone a more detailed and systematic work upon the carnivora of these localities and for the present only to publish the new forms recently found by the museum parties and especially to accurately describe the skeleton of *Daphœnodon superbus*. It is believed that the study of the lower Miocene Canidæ will be facilitated by the publication of an account of the nearly complete skeleton of one individual.

In the following description the exceptionally well preserved and almost complete skeleton of *Daphœnus felinus* Scott (No. 492, Carnegie Museum Catalog of Vertebrate Fossils) which Mr. J. B. Hatcher described (Memoirs Carnegie Museum, Volume I, pp. 65–108) will be used for comparison. In the first place it seems quite certain that *Daphœnus* is in the direct ancestral line of *Daphœnodon*, and secondly, the skeleton from the Oligocene now in the Carnegie Museum, represents the most complete individual of that genus as yet discovered.

Valuable aid in this work was rendered by the authorities of the American Museum of Natural History and of Princeton University Museum, who courteously sent to the Carnegie Museum a number of types for comparison. The illustrations are from drawings made by Mr. Sydney Prentice and photographs by Mr. A. S. Coggeshall and the author.

Family CANIDÆ.

Subfamily Amphicyoninæ.

Daphœnodon superbus (Peterson).

Amphicyon superbus Peterson, Annals Carnegie Museum, Vol. IV, pp. 51–53, Pl. XVIII, 1908. *Daphœnodon superbus* (Peterson), *Science*, N. S., Vol. XXIX, pp. 620–621.

Type: Skeleton nearly complete, No. 1589, Carnegie Museum Catalog of Vertebrate Fossils.

Horizon: Miocene (Lower Harrison Beds).

Locality: Agate Spring Fossil Quarries (Quarry No. 3), Sioux County, Nebraska.

Distinctive characters. — In my previous notes in *Science* I gave the following distinctive characters: *Cranium comparatively short, broad, and low; muzzle large;*

[2] Professor F. B. Loomis, of Amherst, recently discovered two miles east of the Agate Spring Fossil Quarries the greater portion of a fine skeleton which he regards as belonging to the same genus described below.

sagittal crest prominent; brain-case small; incisors heavy and short; canines comparatively small and oval in cross-section; P^4 with antero-internal cusp of moderately large size and located relatively close to the main body of the teeth; M^1 and M^2 large and broad; M^3 present, though small, practically one-rooted and aligned with the internal border of M^1 and M^2. To the above cited characters should be added: $I\frac{3}{3}$ $C\frac{1}{1}$ $P\frac{4}{4}$ $M\frac{3}{3}$; *the symphysis of the inferior ramus separated or slightly coössified; the tubercles of all the molar-premolar teeth blunt; the heel of the lower carnassial tooth large: metatarsals not appressed at their proximal ends; feet sub-digitigrade; tail long and heavy.*

The Skull.

(Plates LXXIV–LXXVII.)

In the articles cited above attention was paid to the cranial and dental characters of *Daphœnodon superbus*. In the present paper, therefore, I will only give a short review of my previous description and add characters which I regard as of interest and importance to the student.

The cranium of this new genus represents an animal very nearly as large as a fully adult gray wolf, but the skull is proportionally shorter and broader, the brain-case smaller, the occipital condyles smaller, the basioccipital and basisphenoid of greater transverse diameter, the paroccipital process further separated from the tympanic bulla and directed more backward, the mastoid larger, the tympanic bulla smaller, and the postglenoid process heavier. When compared with *Daphœnus felinus* the skull is distinctly shorter and broader but the brain-case is evidently not much enlarged and there is a large frontal sinus; the muzzle is heavier; the pterygoids are shorter, and the region back of the pterygoids is apparently also somewhat shortened. The postglenoid and paroccipital processes are of the same relative size and position while the mastoid process is a truncated rounded knob, and is of proportionally greater size. In fact the entire mastoid region of *Daphœnodon* seems to have increased, which is a distinct step away from the line of *Canis.* The space between the paroccipital process and the condyles is shorter, so that the occipital condyles are more sessile in the specimen under description than in the Oligocene genus.[3] The tympanic bullæ are present on both sides in the type specimen; they are of moderately large size and triangular in general outline. The tubular process, which encloses the external auditory meatus is quite prominent and is protected posteriorly by the heavy mastoid, though not so completely coössified with the latter bone as in the recent dogs. On the postero-internal angle of the bulla there is a sharp vertical ridge which unites with a similar though much

[3] In *Daphœnus felinus* (No. 492, C. M. Cat. Vert. Foss.) the base of the skull in the region of the condyles is somewhat injured and the separation of the condyle from the paroccipital process may, in part, be due to this fact.

heavier ridge on the antero-internal angle of the paroccipital process, thus separating the large pit for the tympanohyal externally, the jugular foramen, and the foramen lacerum posterius internally. The bulla seems to be fairly well fused to the tympanic region while in the Oligocene genus it apparently always slipped off. From a study of the tympanic bulla in *Daphœnodon superbus* it is quite evident that though quite solidly attached along the antero-external angle and along the border of the basioccipital, the bone is not nearly so well ankylosed by the paroccipital process and the mastoid as for instance in *Canis*. In *Daphœnus felinus* the bulla appears to be more loosely attached to these processes than in the type under description. This fact apparently supports Mr. Hatcher's contention that the ankylosed auditory bulla in recent dogs should be regarded as a specialized character.[4]

It is interesting to note that the tympanic bulla in *Cynodesmus brachypus* (Cope) is, in the first place, larger; and, secondly, much better ankylosed with the surrounding bones than in the form under description, and more nearly approaches that of *Canis*. Professor Cope[5] and Dr. Matthew[6] have observed that the paroccipital process in *Cynodesmus brachypus* projects "backwards nearly as far as the posterior face of the occipital condyles." After a careful study of this region in the type of *Cynodesmus brachypus*, now before me, it would seem that the backward projection of the paroccipital process, regarded as a primitive character by Matthew, is in reality due very largely to crushing, there being no part of the base of the skull which is left undisturbed. Besides, if the present position of the paroccipital process of the skull of *C. brachypus* is a natural one it would interfere with the free movement of the occipital condyle upon the atlas. Unfortunately the paroccipital process of the left side of *C. brachypus* has been broken off, which otherwise might have furnished good verification. From Dr. Matthew's statement and illustrations (*l. c.*) it is very evident that the paroccipital process in *Cynodesmus thomsoni* is closely connected to the tympanic bulla and points almost directly downward at the tip, while in *Cynodesmus thoöides* Scott[7] the process is heavy and projects more backward. It is quite likely that in a more perfect specimen of *C. brachypus* the condition of the paroccipital process would be found to be more like that in *C. thomsoni* and certainly not more backwardly directed than in *C. thoöides*. The postglenoid process of *C. brachypus* has proportionally a less transverse diameter than in *Daphœndon superbus* and is more nearly similar to that of *Canis*, while the foramen opticum occupies a similar position, *i. e.*, more in advance of the exit of the foramen rotundum than in recent dogs.

[4] "Oligocene Canidæ," MEMOIRS CARNEGIE MUSEUM, Vol. I, pp. 72–73, 1902.

[5] Bull. U. S. Geological and Geographical Survey of the Territories, Vol. VI, p. 389, 1881.

[6] Bull. Am. Mus. Nat. History, Vol. XXIII, p. 186, 1907.

[7] Trans. Am. Philos. Society, Vol. XVII, p. 66, Pl. I, fig. 1893.

In the type under description the greater number of the foramina are well preserved. With the exception of the more internal position of the stylomastoid foramen [8] and the slightly more anteriorly placed foramen opticum, the size and position of the foramina are quite similar to those of *Canis*, which is well illustrated in Plate LXXV. The more internal position of the stylomastoid foramen is due to the large development of the mastoid process and limited backward extension of the tympanic bulla, while the position of the optic foramen may be due to the more advanced position of the orbit in *Daphœnodon* than in *Canis*. The alisphenoid canal is apparently larger in proportion than in the Oligocene genus.

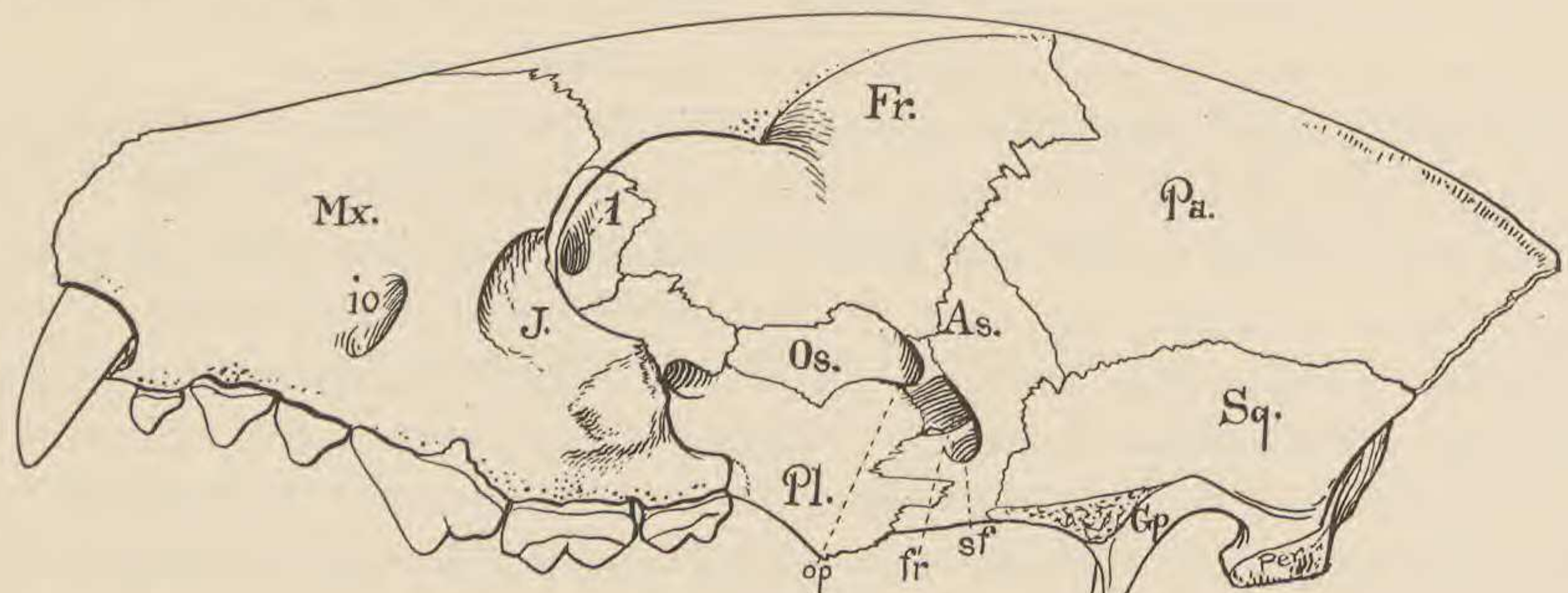

FIG. 2. Skull of young individual of *Daphœnodon superbus*. $\frac{2}{3}$ nat. size. No. 1589a, C. M. Cat. Vert. Foss. *Per*, mastoid portion of periotic; *Gp*, postglenoid process; *J*, jugal; *Pl*, palatine; *Sq*, squamosal; *Pa*, parietal; *Fr*, frontal; *As*, alisphenoid; *Os*, orbitosphenoid; *l*, lachrymal with foramen; *Mx*, maxillary; *io*, infraorbital foramen; *op*, optic foramen; *fr*, foramen rotundum; *sf*, sphenoidal fissure. (Note: The occipital plate, the jugal, the nasals and the premaxillaries are missing and a portion of the zygomatic arch is removed in order to give a better view of the different elements of the skull in this region.)

In Fig. 2 is given a side view of the skull of the younger individual (1589a) which was found together with the type. The premaxillary, nasal, malar, supraoccipital, and the base of the skull are slipped off and lost, but what remains furnishes an admirable idea of each element and their relative proportions in comparison with those in *Canis*. It is seen that the parietal and frontal are longer, lower, and less convex; the alisphenoid of apparently the same proportion; the orbitosphenoid as long, but of less vertical diameter; the lachrymal larger; and the maxillary shorter than in the recent form. From the type specimen the process of the premaxillary, which extends upward between the maxillary and the nasal, is much shorter and weaker than in *Canis* and in this respect more nearly similar to what is observed in *Daphœnus*.

[8] The stylomastoid foramen is not nearly so well separated from the large pit for the tympanohyal as is generally the case in recent dogs.

Lower jaw.—The mandible is quite similar to that of *Canis lupus* in its general characters, but may better be compared with such a form as *Lycaon* on account of its broader symphysis and condyles. The alveolar border is, however, more completely taken up by the premolars in the latter form than in the fossil. There are two mental foramina: one directly below $P_{\overline{2}}$ and the other below $P_{\overline{3}}$. The inferior border of the horizontal ramus is less curved fore-and-aft than in *Daphœnus*, while the line of the alveolar border is about the same. The temporal fossa is broad and deep, the coronoid process large and the process of the angle very robust and more inflected than in *Daphœnus* or the recent forms.

Aside from the large pit, which lodged a considerable sized tympanohyal in the skull, the hyoid arch is not known in *Daphœnodon superbus*.

MEASUREMENTS OF SKULL AND JAWS.

	Mm.
Greatest length of skull	253
Distance from occipital condyle to incisors	228
Distance from occipital condyle to M^3	112
Distance from M^3 to and including the incisors	117
Greatest transverse diameter of the skull	148
Transverse diameter of occipital condyle	46
Greatest transverse diameter of the brain case	58
Transverse diameter of the frontals at postorbital processes	68
Transverse diameter of muzzle at canine	51
Greatest length of mandible	182
Height of mandible at coronoid process	82

Dentition.—The dentition ($I\frac{3}{3}$ $C\frac{1}{1}$ $P\frac{4}{4}$ $M\frac{3}{3}$) of *Daphœnodon superbus* is completely preserved. The first and second upper incisors are laterally compressed and resemble those of *Daphœnus* more than those of recent forms. $I^{\underline{3}}$, however, displays a rapid approach to the characters found in *Canis, i. e.*, it has attained a much larger size and a more nearly caniniform structure. The tooth ($I^{\underline{3}}$) is isolated by diastemata; the one in front being quite short, while the one behind is equal to the greatest transverse diameter of the tooth. As a whole the incisors are proportionally somewhat larger than those of *Daphœnus felinus* and $I^{\underline{3}}$ is distinctly further advanced toward conditions found in *Canis*. As has been stated elsewhere, the canine, though quite robust, is not so large, nor of the shape seen in *Amphicyon giganteus* of Europe, to which genus it was wrongly referred. In the present genus the tooth is of moderately large size, oval in cross-section and recurved quite as in *Canis occidentalis*, though somewhat less compressed than in that species. The base of the tooth and the fang are rounder, which causes a greater swelling on the side of the muzzle than is seen in the latter form.

The molar-premolar teeth have rather blunt cusps. $P^{\underline{1}}$ is single-rooted and has a simple crown ; it is separated from the canine and $P^{\underline{2}}$ by short diastemata. The latter tooth is also isolated, but the diastema back of it is very short. This tooth has two roots ; its crown is comparatively simple, there being no anterior or posterior basal cusps. $P^{\underline{3}}$ is simple-crowned, like the anterior premolar, and otherwise has about the same relative proportions as in *Daphœnus felinus.* Its position in the alveolar border is oblique, which makes it appear of small antero-posterior diameter in the side view of the skull. In $P^{\underline{4}}$ (carnassial) a slight change from what is observed in the Oligocene genus has taken place. The deuterocone is slightly reduced in size and is closer to the main body of the tooth than in either *Daphœnus* or any of the allied John Day forms, and in this respect is more like the corresponding tooth in *Amphicyon major* of Europe. The deuterocone is, however, supported by a much heavier root than either in *Amphicyon* or *Canis* and its oblique position in the alveolar border is totally unlike the latter genera. The smaller antero-posterior diameter and otherwise primitive features of the tooth places the genus rather closer to the Oligocene form and removes it further from *Canis.* $M^{\underline{1}}$ and $M^{\underline{2}}$ are larger than in any of the allied John Day forms (*Temnocyon, Mesocyon, Paradaphænus*) and have also undergone some changes from the corresponding teeth in the Oligocene genus, while $M^{\underline{3}}$ is apparently the same. This change of the molars is principally due to the greater development of the postero-internal angle, which gives these teeth a slightly greater antero-posterior diameter internally than is usually seen in the Oligocene species, and the tooth is otherwise apparently intermediate between that of these early forms and *Canis occidentalis,* which has a very prominent, sharp, and crescentic postero-internal tubercle, especially on $M^{\underline{1}}$. The development of the postero-internal angle is unusually like what we find in *Amphicyon major* and it is quite curious to find the conical structure of the different tubercles so nearly alike in the two genera. $M^{\underline{2}}$ and $M^{\underline{3}}$ of the European genus are, however, proportionally larger, the posterior intermediate cusp (metaconule), especially on M_2, is more strongly developed and the antero-external cusp (paracone) is the larger, while in *Daphœnodon* para- and metacones are subequal and of the primitive type met with in *Daphœnus;* in fact the tubercles are more depressed than in the latter genus, as is seen by referring to the illustrations, Pl. LXXV. The internal border of the grinding surface of $M^{\underline{2}}$ extends slightly below that of the preceding tooth. This character, which is well shown on Pl. LXXIV, may, in part at least, be due to slight displacement. $M^{\underline{3}}$ is, as stated, practically a duplication of that tooth in *Daphœnus, i. e.,* a small tooth with transversely oval and very low crown with a very short root, the alveolus which is posteriorly formed by a thin and very delicate border in the maxillary.

The lower incisors are laterally compressed. $I_{\overline{1}}$ is quite small in comparison with that of *Canis*, while $I_{\overline{2}}$ and $I_{\overline{3}}$, though small, are in better proportion. The canine is robust and resembles that of *Canis occidentalis* very closely, the cross-section of the crown being somewhat more regularly oval and less excavated on the antero-internal angle. $P_{\overline{1}}$ is a small single-rooted tooth with the crown extended well forward from the base, the apex being nearly directly over the anterior face of the root. The tooth is isolated by diastemata, of which the one in front of it is the longer. The next three premolars are also well separated in the jaw. $P_{\overline{2}}$ and $P_{\overline{3}}$ have simple conical crowns with larger posterior than anterior bases and their shape and relative diameters are quite similar to those in *Daphœnus*, while $P_{\overline{4}}$ is somewhat enlarged and has a strong posterior cusp and prominent cingulum similar to some species from the Oligocene, *Daphœnus dodgei* Scott and *Temnocyon altigenis* Cope from the John Day formation of Oregon.

In $M_{\overline{1}}$ (carnassial) is observed the greatest change from what appears in the Oligocene form in the direction of the more recent type. It is at once seen that this tooth has increased in its antero-posterior diameter, the metaconid is situated lower down,[9] and the hypoconid is bluntly trenchant and is greatly developed, while the entoconid is rather small. The tooth is not, however, modified into the perfect shearing blade met with in *Canis*, as it still retains to a greater or less extent the conical structure of the tubercles so characteristic of *Daphœnus* and its ancestors, the *Miacidæ*. $M_{\overline{2}}$ is quite large; the trigonid is raised only very slightly above the heel; the proto-, para-, and metaconids are fused into a more or less solid and obtuse mass, the protoconid being the largest of the three, while the paraconid is represented only as a basal heel on the antero-internal angle. The heel is quite large and is occupied principally by an antero-posteriorly placed ridge (hypoconid) which is low and located nearer the external than the internal border. The entoconid is represented by a low and oblique ledge on the postero-internal angle of the crown. $M_{\overline{3}}$ is single-rooted and is reduced to a small oval-shaped crown with a slight elevation on the anterior half, while postero-internally there is a shallow valley produced, to some extent by trituration. The size of the tooth with reference to the one preceding it is proportionally the same as in *Daphœnus felinus* here used for comparison.

[9] It is interesting to note that *Cynodesmus brachypus* from the Miocene of the Laramie Peak locality is apparently further advanced towards the recent dogs in having the premolars larger, $M\frac{1}{2}$ reduced and the lower carnassial of less transverse diameter.

MEASUREMENTS OF DENTITION.

	Mm.
Length of superior premolar series	55
Length of superior molar series	34
Antero-posterior diameter of superior canine at base	13
Transverse diameter of superior canine at base	10
Antero-posterior diameter of P^1	6
Transverse diameter of P^1	5
Antero-posterior diameter of P^2	11
Transverse diameter of P^2	5
Antero-posterior diameter of P^3	13
Transverse diameter of P^3	7
Antero-posterior diameter of P^4	22
Transverse diameter of P^4, anteriorly	14
Antero-posterior diameter of M^1	19
Transverse diameter of M^1	24
Antero-posterior diameter of M^2	13
Transverse diameter of M^2	18
Antero-posterior diameter of M^3	5
Transverse diameter of M^3	8
Length of inferior premolar series	47
Length of inferior molar series	46
Antero-posterior diameter of inferior canine at base	12
Transverse diameter of inferior canine at base	10
Antero-posterior diameter of P_1	6
Transverse diameter of P_1	4
Antero-posterior diameter of P_2	19
Transverse diameter of P_2	5
Antero-posterior diameter of P_3	13
Transverse diameter of P_3	6
Antero-posterior diameter of P_4	16
Transverse diameter of P_4	8
Antero-posterior diameter of M_1	25
Transverse diameter of M_1	11
Antero-posterior diameter of M_2	14
Transverse diameter of M_2	10
Antero-posterior diameter of M_3	9
Transverse diameter of M_3	7

Although there are a number of apparently strong specific characters in the dentition of the second specimen (No. 1589a) found with the type, I refrain from establishing a second species on account of the immaturity of the specimen. In this second specimen the upper and lower premolars are much more crowded in the alveolar border in comparison with those in the type specimen. The upper carnassial has a better developed postero-external cutting ridge (tritocone) and the cusps are generally more trenchant. P_4 is relatively somewhat larger with a higher crown, the metaconid of the lower carnassial slightly smaller and M_3 two-rooted.

The remains indicate an animal of slightly larger size when fully adult (see Figs. 2 and 3).

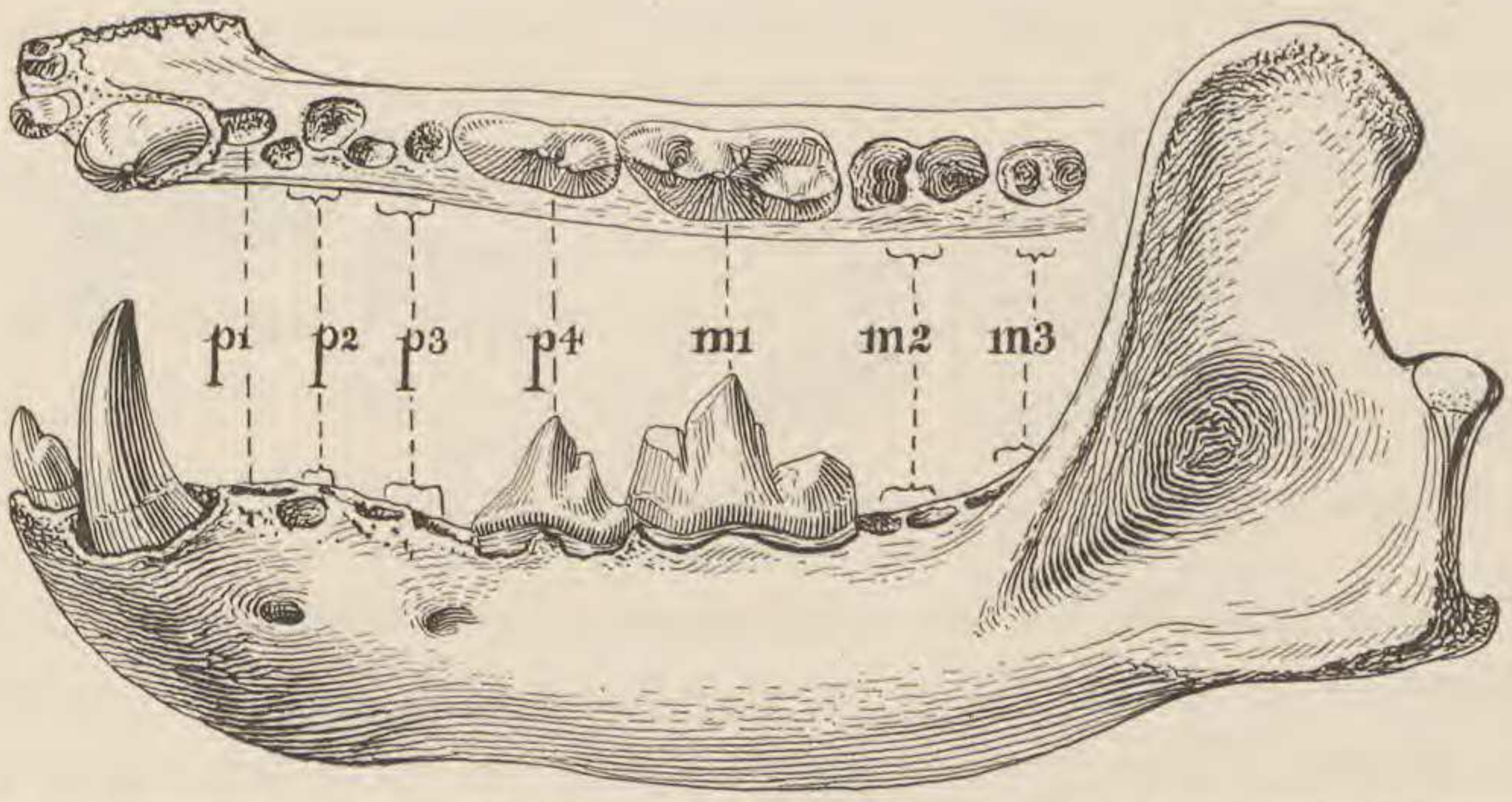

FIG. 3. Lower Jaw of Young Individual of *Daphœnodon superbus*. ⅔ nat. size. No. 1589a.

In section 17 of Quarry No. 1 was found a fragment of a mandibular ramus with the deciduous sectorial in position and the permanent p_4 buried in the jaw. The latter tooth is only partially developed. The different cusps of the deciduous tooth are quite sharp and the heel is of considerable size and completely basin-shaped. The fangs are excessively spread in the antero-posterior direction, due to the constant pressure from below by the permanent tooth, and furnish a sure indication of the juvenility of this tooth. Except for its slightly smaller size, the tooth most nearly resembles that of "*Canis*" *anceps* Scott and is here figured for the purpose of warning the student. The specimen may or may not represent *Daphœnodon superbus*.

FIG. 4. *Daphœnodon superbus?* Fragment of lower jaw of young individual with deciduous sectorial in place and p_4 buried in the jaw (No. 2201). Nat. size.

THE VERTEBRAL COLUMN.

The formula of the vertebral column is as follows: cervicals seven, dorsals thirteen, lumbars seven, sacrals three, and caudals twenty-eight?

With the exception of the missing region of the caudals, already referred to in the introduction, the vertebral column of the type specimen is in excellent preservation.

Atlas.—The atlas is quite long antero-posteriorly. Its large attenuated and wing-like transverse process gives the bone a transverse diameter proportionally equal to that in *Canis*. In general outline the bone is quite similar to that of the latter genus, but there are a number of differences shown on closer examination which reveal conditions more nearly identical with those found in *Daphœnus*. Thus the posterior exit of the vertebrarterial canal is not superior as in the dogs, but more nearly posterior as in the cats;[10] the anterior cotyles are small; the transverse

FIG. 5. Atlas of *D. superbus*. ½ nat. size. 1, dorsal view; 2, lateral view; 3, ventral view.

diameter of the articulation for the axis is proportionally less in size; and the bone, with the exception of the transverse process, is, as a whole, rather heavier than in *Canis*. The atlanteo-diapophysical notch is deep and as in the dogs is not covered with a bony bridge to form a foramen. This character was observed in *Daphœnus* by Professor Scott,[11] while in some of the genera of the *Miacidæ* (*Oödectes*) this notch was already converted into a foramen.[12] The foramen in the arterial groove, which pierces the wall of the neural arch on the ventral face of the transverse process, is exceedingly small, which is also the case in the atlas of *Daphœnus* here used for comparison. In *Canis* this foramen is of larger size.

FIG. 6. Atlas of *Cynodesmus brachypus* Cope. No. 8140, Cope Collection, Am. Museum Natural History. ½ nat. size.

In the atlas of *Cynodesmus brachypus* the posterior exit of the vertebrarterial canal is more dorsally located (see Fig. 6); its atlantal notch is not nearly so deep and the foramen piercing the neural arch on the ventral face of the transverse process is as large as in *Canis*.

MEASUREMENTS OF ATLAS.

	Mm.
Greatest antero-posterior diameter	52
Greatest transverse diameter	99
Antero-posterior diameter at cotyles	39
Transverse diameter of cotyles anteriorly	51
Transverse diameter of cotyles posteriorly	36

Axis. — In comparison with *Canis* the axis is short and high and according to Professor Scott's description of the axis in *Daphœnus* it appears also to differ from that genus in some important and rather surprising details. Scott says: "The cen-

[10] Wortman, J. L., "Osteology of Patriofelis," Bull. Am. Mus. Nat. Hist., Vol. VI, p. 137, 1894.

[11] "Notes on the Canidæ of the White River Oligocene," Trans. Amer. Philos. Society, Vol. XIX, p. 337, 1894.

[12] Matthew, W. D., "Carnivora and Insectivora of the Bridger Basin," Memoirs Am. Mus. Nat. Hist., Vol. IX, p. 367, 1909.

trum is elongate, narrow, and depressed, with a thin and inconspicuous hypopophysial keel." In *Daphœnodon superbus* the centrum, though somewhat depressed, is short in comparison with that of *Canis* and the hypopophysial keel is more strongly developed than in the latter. The ventral face of the centrum in the present genus is not nearly as concave antero-posteriorly as in the dog, and the ventral keel terminates posteriorly in a broader area, which is extended downward very slightly so as to form of its posterior three-fourths a slight antero-posterior concavity, but there is no prominent tubercle as in *Canis*. The articulation for the atlas is more convex and rises higher upon the sides than in *Canis* and is apparently not materially changed from that in the Oligocene form. The odontoid process also agrees with Professor Scott's description of that in the older form, which he says is "a long, slender, bluntly pointed peg, with a heavy, rounded ridge upon its dorsal surface, which is continued back along the floor of the neural canal." The transverse process is heavier, shorter, and is more nearly parallel to the centrum than in *Canis*, which is also characteristic of *Daphœnus*. On the lower border of the transverse process is developed an inferior branch or costal element (see Fig. 7) which is rather unusual on the axis among the dogs and is not mentioned by Scott in his description of this process in *Daphœnus*. The vertebrarterial canal is apparently slightly further forward than in *Daphœnus*, but it is still further back and slightly longer than in *Canis*. The neural canal is large, as in *Daphœnus*, and does not contract so much towards the hinder end as in *Canis*. The spinous process is a long high keel which is produced into a laterally compressed process anteriorly, rapidly expands posteriorly, and is proportionally lighter than in the cats, *e. g.*, *Felis leo*. The posterior face of the spine is excavated somewhat as in *Felis*, though in a less degree, and forms a different attachment for the cervical muscles than is seen on the convex and rugose surface in *Canis*. According to Scott, the neural spine in *Daphœnus* corresponds practically to the description here given.

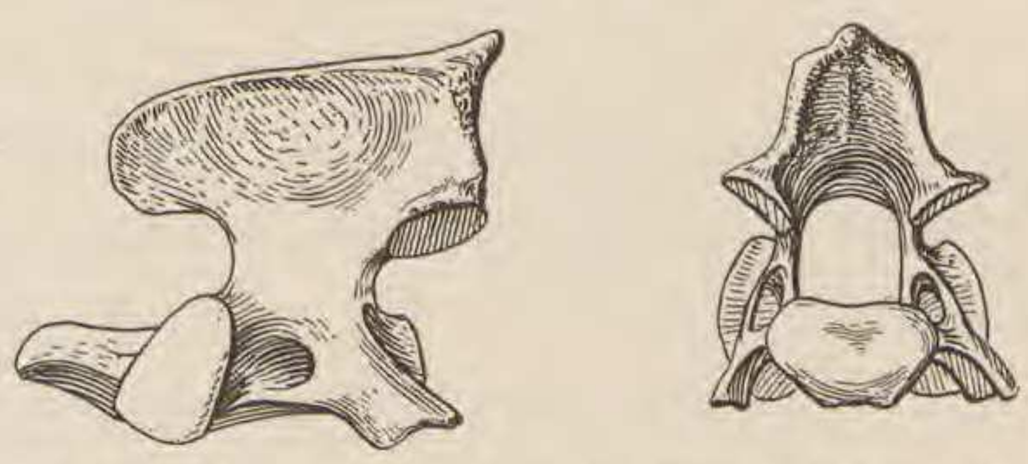

FIG. 7. Lateral and Posterior Views of Axis of *D. superbus*. ½ nat. size.

In *Cynodesmus brachypus* the centrum of the axis is long and narrow and in its general features, including the inferior keel and the odontoid process, answers more nearly to that of *Canis* than to that of *Daphœnus* and *Daphœnodon*, while the neural spine is extremely long and overhanging both anteriorly and posteriorly. The latter process is proportionally longer than that in *Leo*, and tapers more gradually from the base of the postzygapophyses to the free end as in the Eocene creodonts.

MEASUREMENTS OF AXIS.

	Mm.
Antero-posterior diameter of the centrum, odontoid process included	54
Greatest transverse diameter of centrum, anteriorly	36
Greatest transverse diameter of centrum, posteriorly	22
Antero-posterior diameter of spine	53
Transverse diameter across postzygapophyses	34

Third Cervical Vertebra. — The general characters of the third cervical vertebra are similar to those of the same bone in *Canis*, though certain features are rather feline. Thus the inferior branch of the transverse process is strongly developed, the tubercle superior to the postzygapophysis is large and points directly backwards, and the neural spine is considerably developed, while in *Canis* the transverse process is smooth, the tubercle above the postzygapophysis points more upwardly and the neural spine is less developed. The centrum is short and has a strong keel, which terminates posteriorly in a broad area, but does not form a hypopophysial tubercle as in the dogs; the transverse process is shorter and broader, and the vertebrarterial canal is longer.

MEASUREMENTS OF THIRD CERVICAL VERTEBRA.

	Mm.
Antero posterior diameter of centrum	31
Antero-posterior diameter of neural arch including zygapophyses	46
Transverse diameter across transverse processes, posteriorly	52
Transverse diameter of centrum posteriorly	22
Vertical diameter of centrum posteriorly	14

Fourth and Fifth Cervical Vertebræ. — The fourth and fifth cervical vertebræ are heavier than the preceding vertebra. The postero-inferior branch, or costal element of the transverse process, is also more developed; the neural arches are more deeply emarginated in front and behind; the neural spines are higher and the tubercles above the postzygapophyses are smaller. There are otherwise no marked differences between the third, fourth, and fifth cervical vertebræ. In the two latter vertebræ the ventral keel of the centrum does not terminate posteriorly in a tubercle as in *Canis*, but laterally has a broad area with small tubercles, similar to what is observed in *Felis leo*.

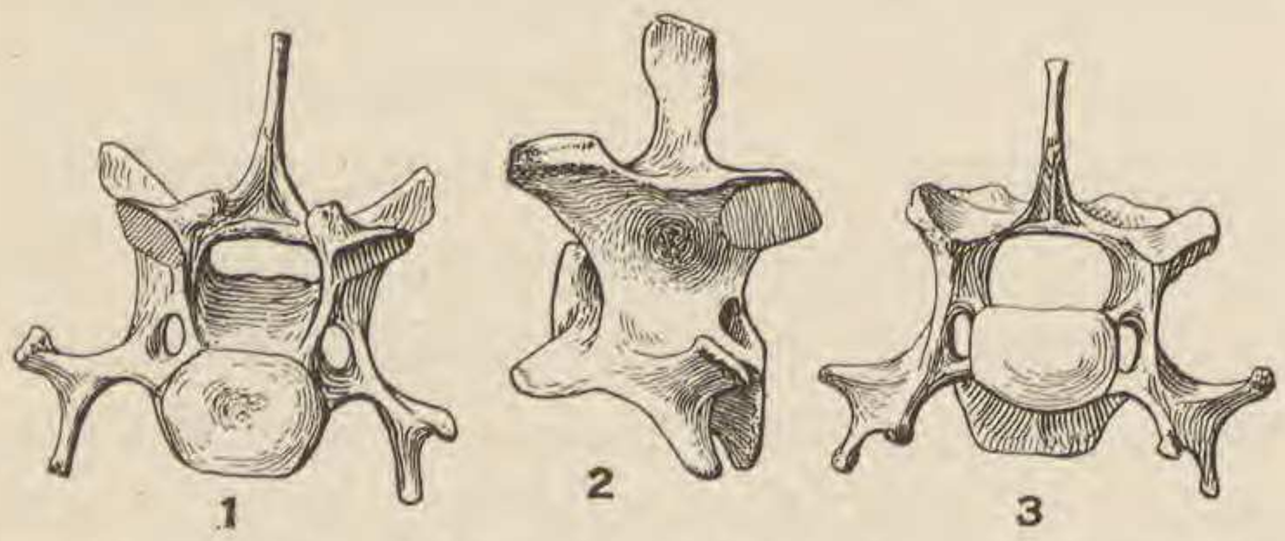

FIG. 8. Fifth Cervical Vertebra of *D. superbus*. $\frac{1}{2}$ nat. size. 1, posterior view; 2, lateral view; 3, anterior view.

MEASUREMENTS OF FOURTH AND FIFTH CERVICAL VERTEBRÆ.

	C. 4 Mm.	C. 5 Mm.
Antero-posterior diameter of centra	31	30
Transverse diameter of centra, posteriorly	22	22
Vertical diameter of centra, posteriorly	15	16
Transverse diameter across transverse processes, posteriorly	55	59
Transverse diameter across prezygapophyses, posteriorly	43	43
Transverse diameter across postzygapophyses	41	39

Sixth Cervical Vertebra. — The sixth cervical vertebra has the faces of the centrum more oblique than in any others of the cervical series, but not more opisthocœlous. The centrum is otherwise depressed and rather broad, as are the centra of all the cervicals. The ventral keel is quite prominent in the anterior region, but fades away to an evenly convex border posteriorly and is quite similar to that in *Canis.* The transverse process is very prominent, as in the latter genus, but the inferior lamella is divided into two parts, a small anterior and a larger posterior portion (see fig. 9). In the thoöids this lamella forms a solid and thin blade, while in the alopecoids it is generally slightly divided. In the cats it is divided in a greater or less degree. The vertebrarterial canal is proportionally longer than in *Canis.* The neural arch is broad, but does not form the connecting ledge between the pre- and postzygapophyses as prominently as in *Canis*; there is no excessory process developed on this connecting ledge as in the latter genus, though it would appear from Professor Scott's description (*l. c.*, p. 338) that these ledges are perhaps more prominent on the arches of the cervical vertebræ in the present genus than in *Daphœnus.*

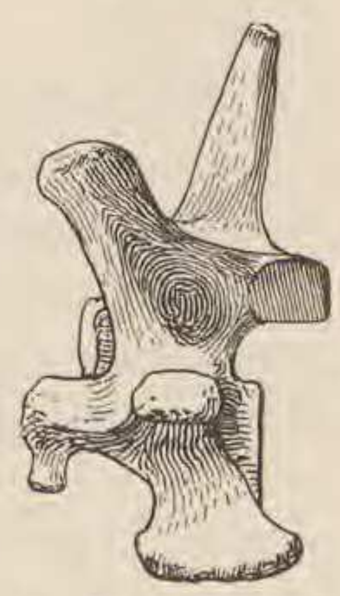
FIG. 9. Sixth Cervical Vertebra of *D. superbus.* ½ nat. size.

The anterior and posterior emarginations on the neural arches which separate the zygapophyses in front and behind the neural spines of the cervical vertebræ are deeper than in *Canis*; they are not unlike those in *Viverra africana*, and in this respect are similar to what was found by Scott to be the case in the Oligocene genus. The neural spine of the sixth cervical in the type is slightly damaged, but its entire length is represented, and it is shown to be robust and high.

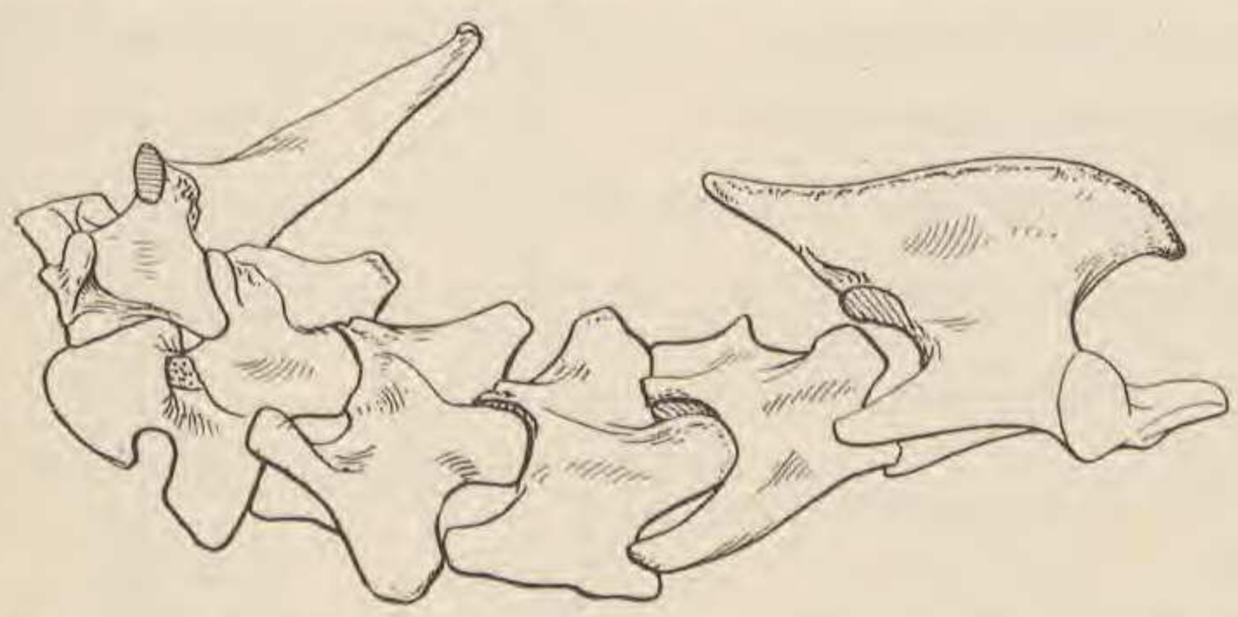
FIG. 10. Cervical Vertebræ of *Cynodesmus brachypus* Cope (No. 8140 Cope Collection, Am. Museum of Natural History). ½ nat. size.

In the sixth cervical vertebra of *Cynodesmus brachypus* the inferior branch of the transverse process is divided, but the anterior portion is much larger proportionally than that in *Daphœnodon*. In all other respects the bone is more nearly like that in *Canis* than *Daphœnodon*. In fact the entire cervical series in *C. brachypus* is strikingly similar to that of the recent form except that the posterior exit of the vertebraterial canal of the atlas is further back, the neural spine of the axis more produced posteriorly, the inferior lamella of the transverse process of the sixth cervical is divided, and the neural spine of the seventh cervical is more robust and higher.

MEASUREMENTS OF SIXTH CERVICAL VERTEBRA.

	Mm.
Antero-posterior diameter of the centrum	29
Transverse diameter of the centrum posteriorly	23
Vertical diameter of the centrum posteriorly	27
Transverse diameter at transverse processes	59
Transverse diameter of prezygapophyses	43
Transverse diameter of postzygapophyses	57

Seventh Cervical Vertebra.— The seventh cervical is characterized by its long and heavy transverse processes and neural spine, which are proportionally quite large when compared with those of *Canis*. From Professor Scott's observation it is quite clear that *Daphœnus* also had high neural spines on the cervical vertebræ, which is generally characteristic of the felines. It is further noticed that the anterior and posterior faces of the neural spine of the seventh cervical in *Daphœnodon* have conspicuous excavations at the base, which are not present in *Canis* and *Felis*, while in *Viverra zivetta* they are represented to a slight extent. These excavations have rough surfaces for muscular attachment, and the one posterior is deeper than the one anterior. The four vertebræ preceding the one under description have similar rough excavations (see Fig. 8) and these excavations also appear in the case of the anterior dorsals. (See Fig. 13.)

FIG. 11. Seventh Cervical Vertebra of *D. superbus*. ½ nat. size.

MEASUREMENTS OF SEVENTH CERVICAL VERTEBRA.

	Mm.
Antero-posterior diameter of centrum	27
Transverse diameter of centrum posteriorly	25
Vertical diameter of centrum posteriorly	18
Transverse diameter of transverse processes	67
Transverse diameter of prezygapophyses	43
Transverse diameter of postzygapophyses	43
Height of neural spine	47

First Dorsal Vertebra.—The centrum of the first dorsal is, as in *Daphænus*, broad and depressed, which seems to be true of the dogs generally. The transverse process is heavier than in *Canis lupus.* The postzygapophyses point forward and outward in a greater degree; their zygapophysial articulations are larger and present a more obliquely concave appearance than in the later genus, while the postzygapophyses are quite similar in every respect. The neural spine is robust and high, but on the whole proportionally lighter than in *Canis.* The excavations on the spine referred to in the description of the preceding vertebra are also continued to the dorsal series, and in his description of *Daphænus* (*l. c.*, p. 339) Scott speaks of this condition as follows: "the notch between them [prezygapophyses] is very deeply incised, invading the base of the spine, a very different arrangement from that seen in *Canis.*"

FIG. 12. First Dorsal of *D. superbus.* ½ nat. size.

MEASUREMENTS OF FIRST DORSAL VERTEBRA.

	Mm.
Antero-posterior diameter of the centrum	25
Transverse diameter of the centrum	29
Vertical diameter of the centrum	16
Transverse diameter across the transverse processes	63
Transverse diameter across prezygapophyses	45
Transverse diameter across postzygapophyses	30
Height of neural spine	60

Second Dorsal Vertebra.—The centrum of the second dorsal is less depressed than that of the first, its anterior face being of more nearly circular outline and quite convex. Ventrally there are two prominent ridges on either side of the median keel, which extend nearly the entire length of the centrum. The transverse process and the zygapophyses are lighter than on the preceding vertebra. The prezygapophyses face inward and slightly upward; at their lower margins they are abruptly concave, due to sharp ridges at their bases which extend diagonally upward and inward, uniting with the anterior border of the neural spine a short distance above the arch. The triangular area on the anterior face of the spine, which is bounded laterally by these ridges, is quite deep and has a rugose surface identi-

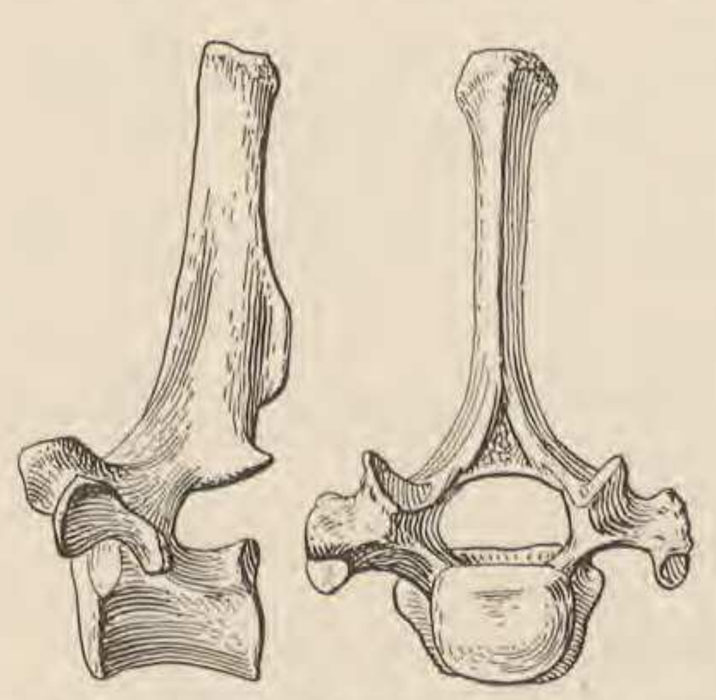

FIG. 13. Lateral and Posterior Views of Second Dorsal of *D. superbus.* ½ nat. size.

cal with that which has been described in the preceding vertebra, and is well shown in the illustration, Fig. 13.

MEASUREMENTS OF SECOND DORSAL VERTEBRA.

	Mm.
Antero-posterior diameter of the centrum	23
Transverse diameter of the centrum, posteriorly	27
Vertical diameter of the centrum, posteriorly	16
Transverse diameter at the transverse processes	50
Transverse diameter at the prezygapophyses	55
Transverse diameter at the postzygapophyses	22
Height of neural spine	57

Third and Fourth Vertebræ.—The third and fourth dorsals have their centra similar to that of the second. The transverse processes are lighter, the prezygapophyses are less complicated, facing directly upward, and the neural spines are less expanded at the top than in the preceding vertebra; there are otherwise no characters which require a separate description.

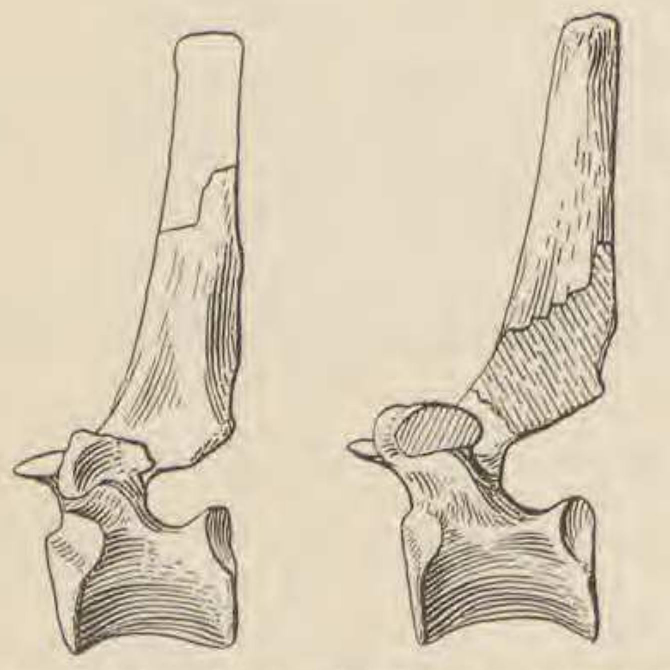

FIG. 14. Lateral Views of Third and Fourth Dorsals of *D. superbus*. ½ nat. size.

MEASUREMENTS OF THIRD AND FOURTH DORSAL VERTEBRÆ.

	D. 3. Mm.	D 4. Mm.
Antero-posterior diameter of centra	23	25
Transverse diameter of centra	25	23
Vertical diameter of centra	16	16
Transverse diameter at transverse processes	47	44
Transverse diameter at prezygapophyses	24	21
Transverse diameter at postzygapophyses	20	
Height of neural spine approximately	57	56

Fifth, Sixth, Seventh, Eighth, and Ninth Dorsal Vertebræ.—This series of dorsals are so similar to one another that they do not each require a separate description. The centra are quite uniformly concave on the sides and have a ventral keel more or less indicated, while the individual increase in the antero-posterior diameter from the fifth to the ninth is hardly perceptible. The articular surfaces for the ribs are large and the intervertebral notches are low but of considerable antero-posterior dimensions. The transverse

FIG. 15. Ninth Dorsal of *D. superbus*. ½ nat. size.

processes decrease but very slightly from the fifth to the ninth, the articular surfaces for the ribs are extensive on the free and expanded ends, but the excessory processes on the superior faces, which are so prominent in the recent dogs, are very inconspicuously developed. The neural spines in the whole series are heavy, but gradually reduced in height in proceeding backward, the ninth being quite thin transversely though broad antero-posteriorly.

MEASUREMENTS OF FIFTH AND NINTH DORSAL VERTEBRÆ.

	D. 5 Mm.	D. 9 Mm.
Antero-posterior diameter of centra	24	25
Transverse diameter of centra	24	26
Vertical diameter of centra	16	17
Transverse diameter at transverse processes	50	47
Height of neural spines	60	43

Tenth Dorsal Vertebra.—The centrum of the tenth dorsal vertebra is similar to that of the ninth, with the exception of the absence of facets for the capitulum of the rib. The transverse process is still quite heavy and has a large facet for the tuberculum of the rib, as is well shown in Fig. 16. The prezygapophysis is like that in the preceding vertebra, while the postzygapophysis is placed high and faces downward and outward, similarly to that in the recent dogs. The neural spine, however, is very characteristic in the present genus and different from that in the recent form. In *Canis lupus* the spine is thin transversely, quite broad antero-posteriorly, very low and upright in position — a character which was apparently already established in some of the early tertiary forms (*Miacidæ*).[13] In *Daphœnodon superbus* the neural spine of this vertebra is more backwardly inclined, and, with the exception of the postzygapophysis and the sudden reduction in size, it is like that in the true dorsals. In *Canis latrans* the neural spine of the tenth dorsal is apparently quite similar to the one here described, though much shorter in proportion.

FIG. 16. Tenth Dorsal of *D. superbus.* ½ nat. size.

MEASUREMENTS OF TENTH DORSAL VERTEBRA.

	Mm.
Antero-posterior diameter of centrum	25
Transverse diameter of centrum, posteriorly	25
Vertical diameter of centrum	16
Transverse diameter at transverse processes	47
Height of neural spine, approximately	35

[13] Matthew, W. D., "Carnivora and Insectivora of the Bridger Basin," Memoirs Amer. Mus. Nat. Hist., Vol. IX., p. 367, 1909.

Eleventh Dorsal Vertebra.—The centrum of the eleventh dorsal vertebra is longer and also of slightly greater vertical diameter than is the case in the preceding vertebra and, as in the latter, there are no facets for ribs on the posterior face. The eleventh and twelfth dorsals in the skeleton of *Daphœnus felinus* (No. 492) have no facets on the posterior faces, although there are instead little rounded processes which extend slightly behind the faces of the centra, but which apparently never touched the heads of the ribs, as there are no articular facets noticed on them.

FIG. 17. Eleventh Dorsal of *D. superbus*. ½ nat. size.

The characters of the neural arch, zygapophyses, and spinous process are suddenly changed in this vertebra, and are on the whole more like those of the true lumbars. The bone is injured in the region of the transverse process, but enough is preserved to indicate its rather small size, and it is quite doubtful whether it carried an articular facet for the tuberculum of the rib as in *Canis* and other recent Carnivora. The meta- and anapophysis are more prominent than in *Canis;* in fact the vertebra as a whole is heavier. Judging from the base of the neural spine it was thin transversely and rather broad antero-posteriorly; it did not attain a great height, and was perhaps more or less anticlinal.

MEASUREMENTS OF ELEVENTH DORSAL VERTEBRA.

	Mm.
Antero-posterior diameter of centrum	26
Transverse diameter of centrum	24
Vertical diameter of centrum, approximately	17
Transverse diameter at transverse processes	37
Height of neural spine, approximately	15

Twelfth and Thirteenth Dorsal Vertebræ.—The twelfth and thirteenth dorsal vertebræ increase rapidly in size from the one preceding them. The twelfth is characterized by the practical absence of a transverse process, there being only a trace of a tubercle present near the posterior border of the pedicel immediately above the intervertebral notch. On the thirteenth dorsal is a decided knob-like transverse process which is shifted lower down than on the eleventh. The ventral keel is a heavy rounded ridge and is more prominently developed on the thirteenth than on the last vertebra mentioned. The meta- and anapophyses are seen to be decidedly more robust in the two vertebræ here described

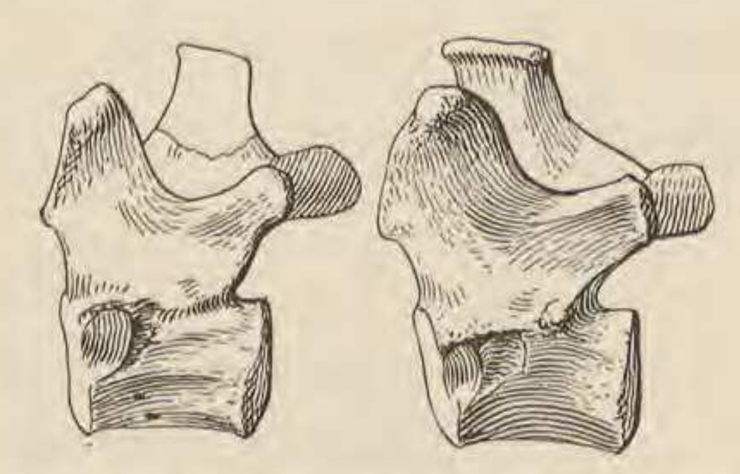

FIG. 18. Twelfth and Thirteenth Dorsal Vertebræ of *D. superbus*. ½ nat. size.

and the zygapophyses and neural spines, especially of the thirteenth dorsal, are typically lumbar in character.

MEASUREMENTS OF TWELFTH AND THIRTEENTH DORSAL VERTEBRÆ.

	D. 12 Mm.	D. 13 Mm.
Antero-posterior diameter of centra	28	29
Transverse diameter of centra posteriorly	26	27
Vertical diameter of centra posteriorly	17	19
Transverse diameter at transverse processes	31	33
Height of neural spine		25

First Lumbar Vertebra. — The first lumbar vertebra is slightly larger than the last dorsal. Besides the absence of facets for ribs it also differs from the latter in having a sharper ventral keel, better developed lateral tubercles on the ventral posterior face of the centrum, larger transverse processes, which are placed lower down, and a slightly heavier neural spine. In *Daphœnus felinus* the lumbar vertebræ have relatively longer and narrower centra, with the ventral keel and lateral posterior tubercles of greater prominence, longer transverse processes, and the neural spines possibly somewhat higher than in the present genus.

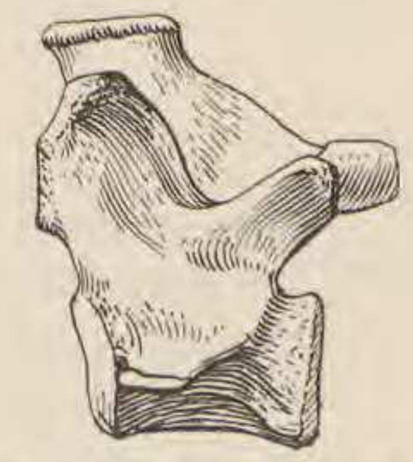

FIG. 19. First Lumbar Vertebra of *D. superbus*. ½ nat. size.

MEASUREMENTS OF FIRST LUMBAR VERTEBRA.

	Mm.
Antero-posterior diameter of centrum	33
Transverse diameter of centrum	27
Vertical diameter of centrum	19
Transverse diameter at transverse processes, approximately	45
Height of neural spine	26

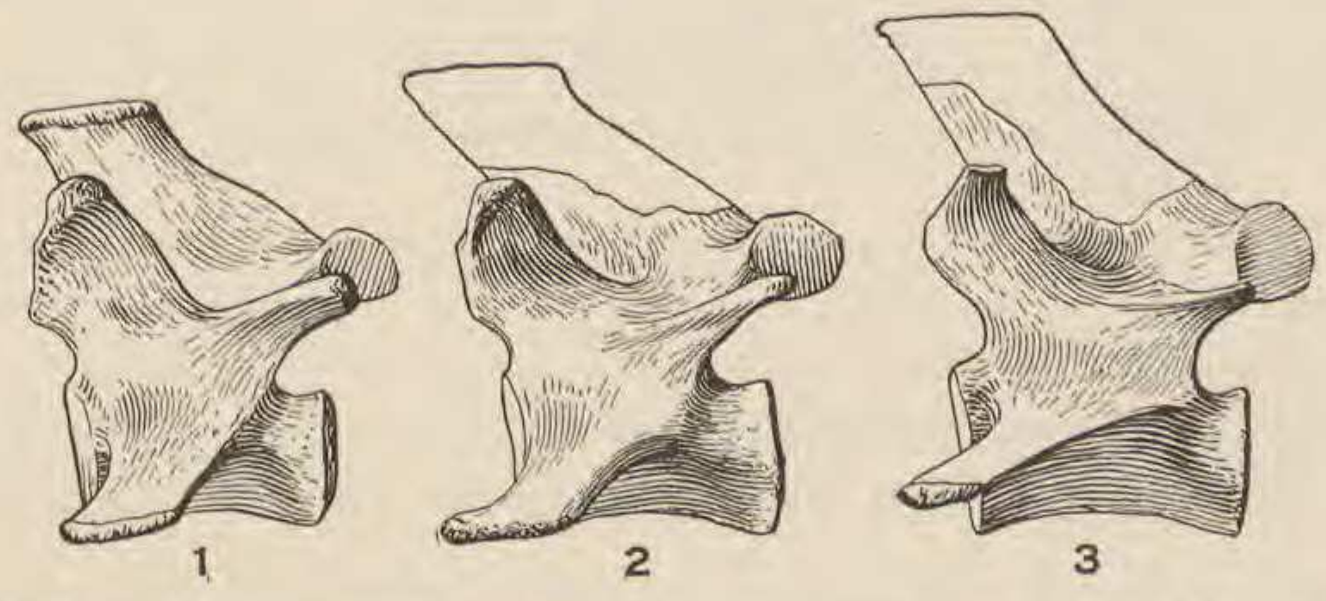

FIG. 20. Lumbar Vertebræ of *D. superbus*. ½ nat. size. 1, second lumbar ; 2, third lumbar ; 3, fifth lumbar.

Second, Third, Fourth, and Fifth Lumbar Vertebræ. — This series of the lumbars may conveniently be described together. Their centra are broad and heavy, not unlike those in *Canis*, while the transverse processes, though quite heavy and directed forward, are much shorter than in the latter genus. The latter character is a curious feature of this genus which seems to have departed from *Daphœnus*, *Temnocyon*,[14] and also from the recent canids generally, while, according to observations by Dr. Matthew (*l. c.*, p. 367) upon *Miacis*, its affinity with regard to the short transverse processes would seem to recall the earlier tertiary types. As in *Daphœnus* the metapophyses, anapophyses, and neural spines are proportionally more robust than those in the recent dogs. The meta- and anapophyses are heaviest on the first lumbar and gradually decrease in size backwards, the anapophysis of the fifth lumbar being quite small. Except on the first, second, and seventh lumbars the neural spines are broken off superiorly, but enough remains to ascertain their great antero-posterior diameters, which are not unlike those in canids generally.

MEASUREMENTS OF SECOND AND FIFTH LUMBAR VERTEBRÆ.

	L. 2 Mm.	L. 5 Mm.
Antero-posterior diameter of centra	36	40
Transverse diameter of centra posteriorly	27	29
Vertical diameter of centra posteriorly	19	19
Transverse diameter of transverse processes	50	72
Length of transverse processes from base (posterior) to tip end	14	24
Height of neural spine	18	?

FIG. 21. Sixth Lumbar Vertebra of *D. superbus*. ½ nat. size.

Sixth Lumbar Vertebra.—The sixth lumbar vertebra is characterized by the absence or very rudimentary development of anapophyses, and also by a considerable transverse broadening of the centrum posteriorly. There is otherwise very little difference between this vertebra and the one preceding it.

MEASUREMENTS OF SIXTH LUMBAR VERTEBRA.

	Mm.
Antero-posterior diameter of centrum	40
Transverse diameter of centrum	31
Vertical diameter of centrum	19
Transverse diameter at transverse processes, approximately	84
Height of neural spine, approximately	45

Seventh Lumbar Vertebra.—The centrum of the seventh lumbar vertebra is as usual quite depressed. The transverse diameter of the posterior face is nearly equal to its antero-posterior diameter and the ventral keel and lateral ridges are prominent, especially on the anterior half of the centrum. The transverse process is

[14] Eyerman, J. "The Genus Temnocyon and a New Genus thereof, etc." Amer. Geol., Vol. XVII, pp. 273–274, 1896.

unfortunately not completely preserved; enough remains, however, to determine that it is fully as heavy as in *Canis*, but probably did not attain the length seen in the latter. The pre- and postzygapophyses, especially in the latter, are much expanded in comparison with those of the preceding lumbars, and the neural spine is also quite light, although comparatively heavier than in the recent dogs.

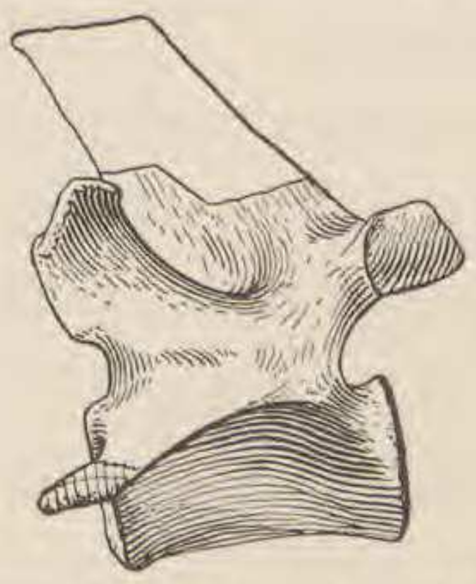

FIG. 22. Seventh Lumbar Vertebra of *D. superbus*. ½ nat. size.

In the type of *Cynodesmus brachypus* the lumbar series (seven) is apparently completely represented. The centra, especially in the anterior part of the series, are somewhat less depressed than in *Daphœnodon*. The transverse processes, though relatively longer than in *Daphœnodon*, are not attenuated to the same degree as in recent dogs. The metapophyses, anapophyses, and neural spines are proportionally lighter than in *Daphœnodon* and on the whole more nearly resemble the lumbar vertebræ of *Canis*.

MEASUREMENTS OF SEVENTH LUMBAR VERTEBRA.

	Mm.
Antero-posterior diameter of centrum	34
Transverse diameter of centrum posteriorly	31
Vertical diameter of centrum posteriorly	18
Transverse diameter at transverse processes, approximately	72
Height of neural spine	33

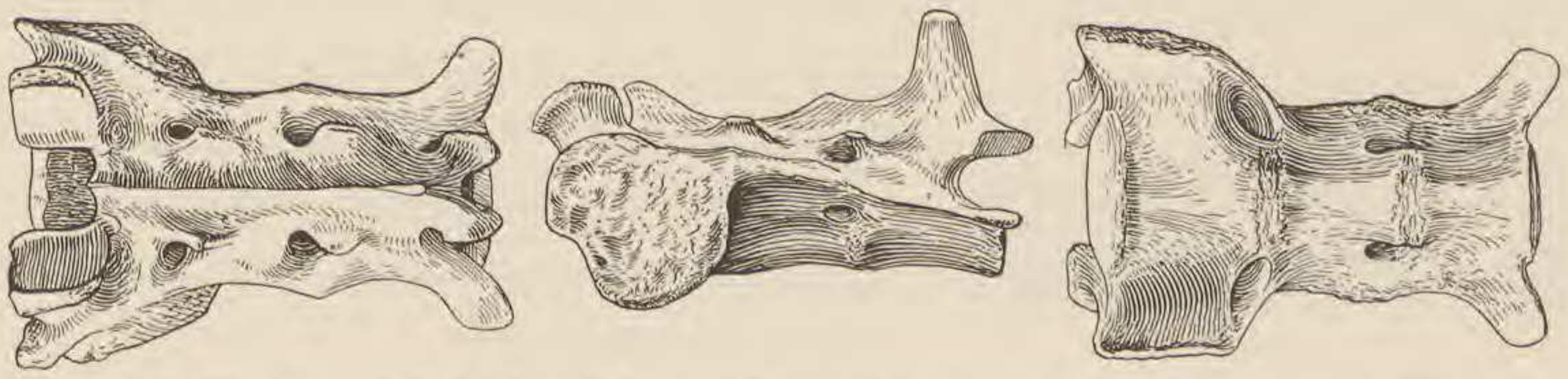

FIG. 23. Dorsal, Lateral, and Ventral Views of Sacrum of *D. superbus*. ½ nat. size.

Sacrum. — The sacrum is greatly developed, and, as usual, it consists of three well coössified vertebræ. In its relative size it is fully equal to that of *Daphœnus* described and figured by Professor Scott (*l. c.*, p. 341, Pl. XX, fig. 14), and is very much larger than in the recent dogs and proportionally somewhat more robust than in the lion or the tiger. The centra are unusually massive and not nearly so depressed as in the recent dogs, but resembling more those of the tiger. The transverse processes however, are, very differently arranged, only the first sacral supporting the ilium by its very heavy pleurapophyses; the second has the transverse process represented by a comparatively delicate roughened ridge, while the third has a prominent process which extends laterally and slightly back of the posterior face of the centrum. In the recent forms the transverse processes of the sacrum are more strongly developed, the first and second sacrals, especially, taking a more prominent part in the support of the ilium. In comparison with the heavy centra the neural canal is rather small, thus agreeing with what is observed in the Oligocene genus and differing from recent forms. The neural spine of the first sacral is relatively smaller than in the recent dogs or cats, while that of the last sacral is much heavier, the spine on the median vertebra consisting only of a sharp low ridge, which uninterruptedly connects with the spines in front and behind.

In *Cynodesmus brachypus* the sacrum is shorter and broader, the second sacral helps to support the ilium more prominently and the anterior neural spines were apparently proportionally more robust than in *Daphœnodon*. The spinous process on the last sacral in *C. brachypus* however, is, quite prominent, and is more completely separated from the spine in front of it than in either *Daphœnodon* or the recent dogs.

MEASUREMENTS OF SACRUM.

	Mm.
Antero-posterior diameter of centra	77
Greatest transverse diameter across the pleurapophyses	59
Greatest transverse diameter at transverse processes of last sacral	49

Caudal Vertebræ. — The tail is very long and heavy; it has undergone practically no change from that of the Oligocene form and is practically as well developed as in the lion or the tiger. The anterior face of the centrum of the first caudal is more convex and less depressed than the posterior. The transverse process is very heavy and projects well backwards. The pre- and postzygapophyses have perfectly formed articular facets and are well expanded transversely. The neural canal is of moderately large size and the spinous process is quite robust.

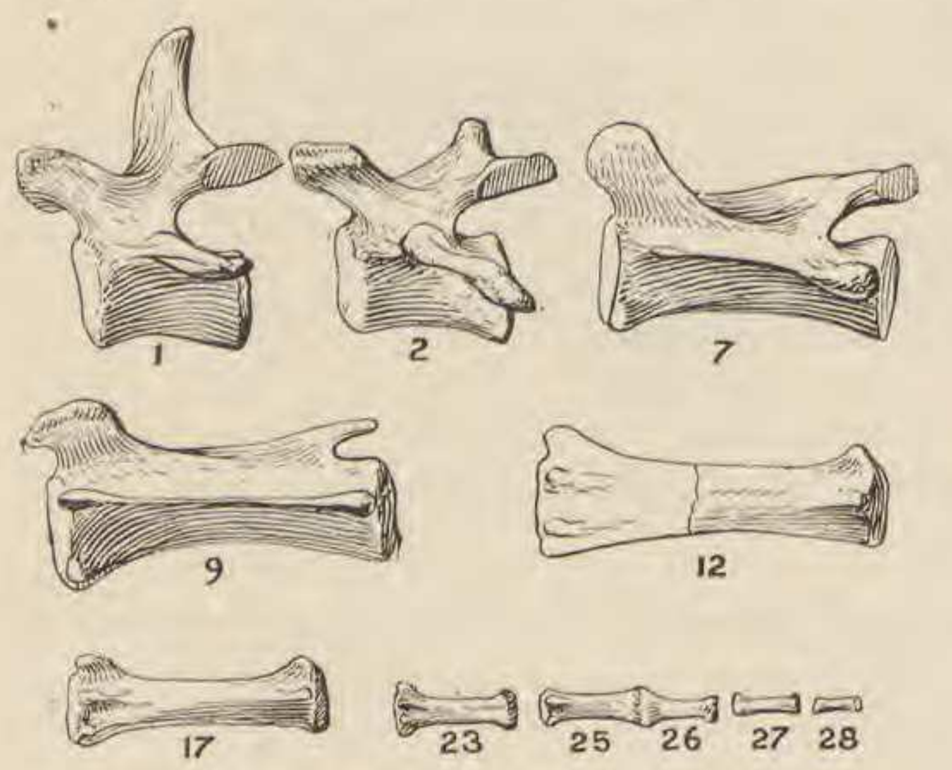

FIG. 24. Caudal Vertebræ of *D. superbus*. ½ nat. size. (1-28 indicate their respective positions in the tail.)

The length of the centra of the succeeding two caudals agrees with that of the first. The transverse process on the second however, is, broader antero-posteriorly than in the first, but the neural spine is very much reduced, while on the third caudal the neural spine is represented only by a low ridge. The centrum of the fourth caudal is four or five millimeters longer than that of the first, while back of this vertebra the increase in length is more noticeable. The transverse processes are single up to the sixth, and the seventh caudal still bears the pre- and postzygapophyses with perfect articular facets in front and behind, while on the eighth and ninth the postzygapophyses are more or less imperfect, but the neural canal is complete and extends throughout nearly the entire length of the vertebræ. The last mentioned vertebra is the longest in the series which was attached to the sacrum when the specimen was found, but there is reason for believing that the vertebra continued to increase in length up to the eleventh or twelfth caudal. There are seven chevron bones present which were found more or less in position in the series of caudals here described.

At the anterior portion of the tenth caudal the skeleton was exposed and a section of the tail dropped out. As mentioned in the introduction, the natural curve in which the tail undoubtedly was lying would allow room for six or possibly seven vertebræ. Working on this hypothesis the next vertebra which was found in position in the skeleton would be the seventeenth or eighteenth. This vertebra has the pre- and postzygapophysial prominences, anterior transverse processes, and ventral tubercles for chevrons well represented, and the centrum is of considerable length and robustness. The ten succeeding vertebræ gradually decrease in length and robustness, the last being only seven millimeters long.

In the type of *Cynodesmus brachypus* the anterior four caudal vertebræ are present together with various others which represent different parts of the tail. The transverse process on the first is very long and robust, while on the second it is much shorter and indicates a greater decrease backward than is seen in *Daphænodon*. The centra are less depressed than in the latter genus and approach more closely those in the dogs. It is quite likely that the tail in *C. brachypus* when completely known will be found to be proportionally shorter than in *Daphænodon superbus*.

Measurements of Caudal Vertebræ.

	C. 1 Mm.	C. 2 Mm.	C. 9 Mm.	C. 17 Mm.	C. 28 Mm.
Antero-posterior diameter of centra	23	24	46	35	7
Transverse diameter of centra posteriorly	22	20	16	8	2
Vertical diameter of centra posteriorly	15	14	14	9	2
Transvere diameter at transverse processes	57	67	26	12	

Ribs and Sternum.

There are very few ribs represented with the type specimen, while in No. 1589a (the young individual found with the type) they are quite complete. The series as a whole is rather short and stout with much expanded ventral ends. In the anterior region of the thorax the ribs have large capitular and tubercular articulations and rather flat shafts as in *Canis*, while posteriorly they are more cylindrical; the eleventh, twelfth, and thirteenth having no tubercular articulations.

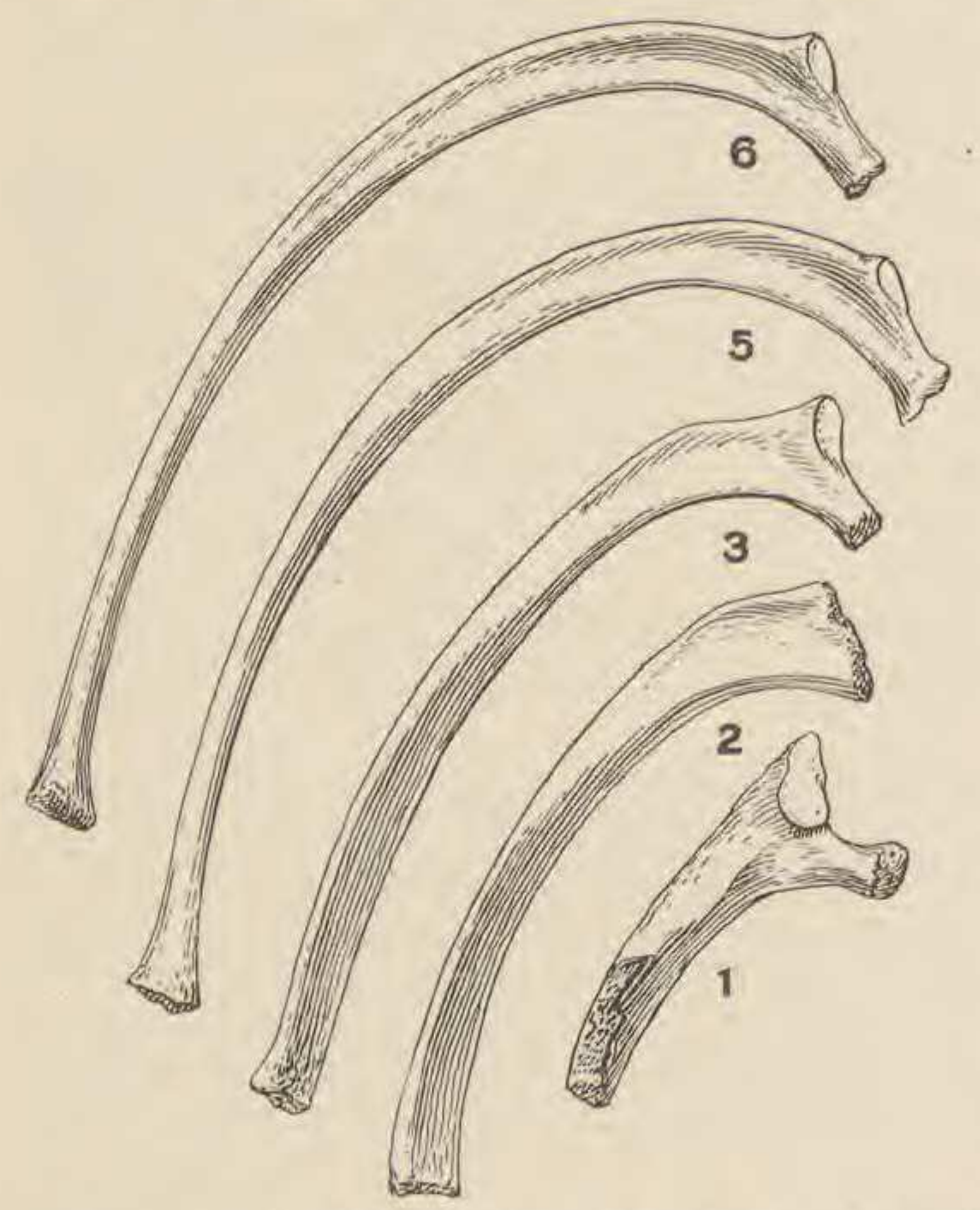

FIG. 25. Ribs of Left Side of *D. superbus.* ½ nat. size. 1, first rib, type No. 1589; 2, second rib No. 1589a; 3, third rib No. 1589a; 5, fifth rib No. 1589a; 6, sixth rib No. 1589a.

Sternum.— The sternum is represented only by the manubrium, which is more nearly like that in the tiger than in the dogs. Thus its size is proportionately large and it is greatly produced in front and much expanded transversely at the attachment for the first pair of ribs. In front of the rib facets the superior face has a subtriangular area which is concave from side to side and also slightly concave antero-posteriorly. In front the bone terminates in an obtuse, laterally compressed process, which projects forward and slightly downward. The ventral face is produced into a heavy rounded antero-posterior ridge, which gives the bone a strong keel-like appearance. The posterior half of the presternum is more angular on cross-section.

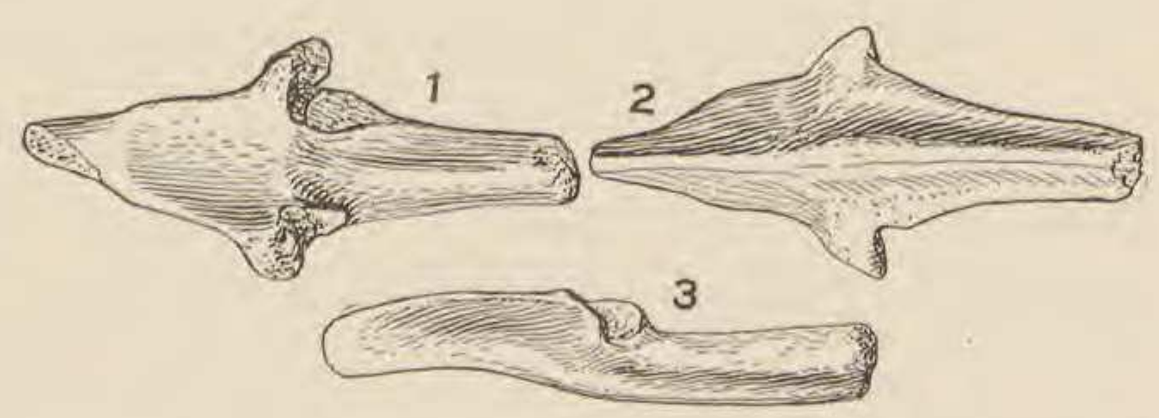

FIG. 26. Presternum of *D. superbus.* ½ nat. size. 1, dorsal view; 2, ventral view; 3, lateral view.

MEASUREMENTS OF PRESTERNUM.

	Mm.
Greatest length	73
Transverse diameter at first rib facets	33
Vertical diameter at first rib facets	13

THE OS PENIS.

The os penis which is so well developed and characteristic in *Daphœnus* is not less so in *Daphœnodon.* With the type and the younger skeleton there was found the anterior portion of an os penis (Fig. 27, 2) which I judge might belong with the young individual. The portion of the shaft present is sub-cylindrical in cross-section, with a sinuous curve and deeply grooved near the bisected end.

In the material belonging to a skeleton of *Daphœnodon* in Amherst College, Massachusetts, now in the Carnegie Museum,[15] there is an os penis of very large size, and also different in its general shape from that described above (see Fig. 27, 1).

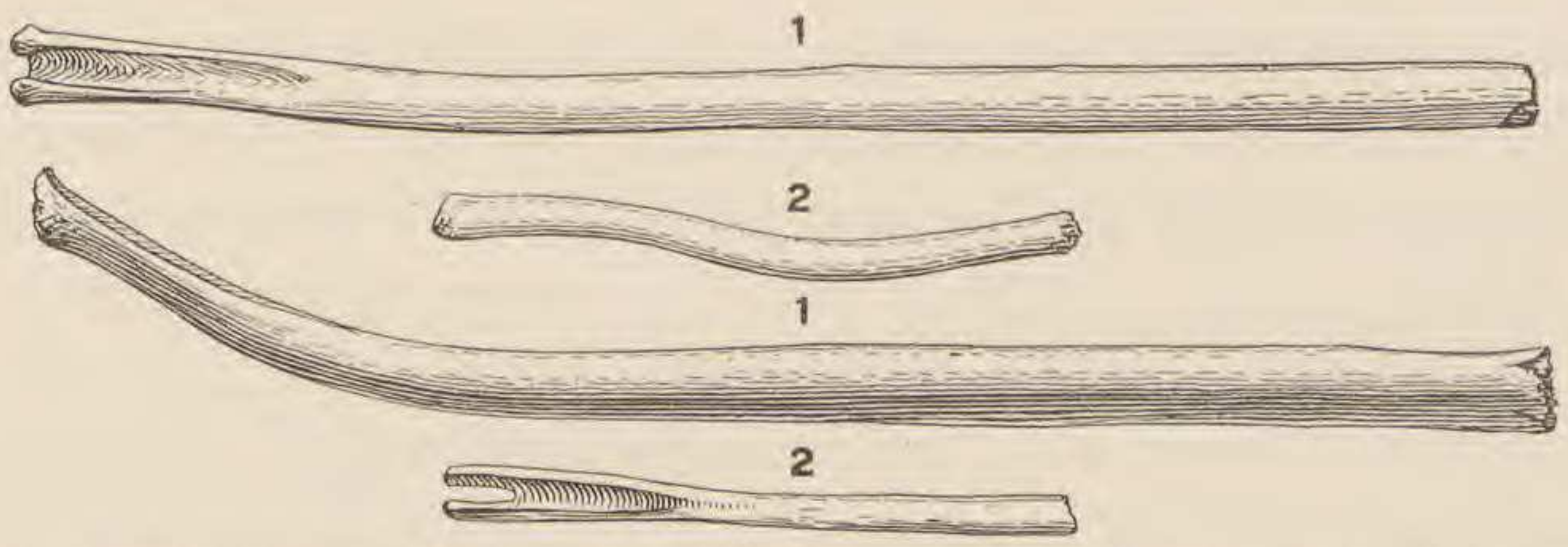

FIG. 27. Os Penis of *D. superbus*. ½ nat. size. 1, superior and lateral views of os penis, Amherst specimen; 2, superior and lateral views of os penis with skeleton No. 1589a, Car. Mus. Cat. Vert. Foss.

Thus its shaft is more elliptical in cross-section, especially toward the posterior end, and it has a less complex curvature at the anterior end. It is, however, deeply grooved near the anterior end as in the smaller specimen, though not bisected, but suddenly expanded to a round spout with many small tubercles on the anterior border. How much longer this bone was is rather difficult to say, but it would seem that it is broken off immediately in front of the rugose surface for the attachments of muscles to the pubes. Whether the larger bone represents the fully adult stage of development or pertains to another species cannot now be fully determined. If, on the other hand, the two different bones represent fully adult forms there is apparently a great range of variation of this bone in this genus.

The Fore Limb.

(Plates LXXVIII–LXXX.)

Scapula (Plate LXXVIII). The scapula is well preserved and completely represented in the type specimen as well as the younger specimen found with it. This important bone of the fore limb displays a number of rather surprising features and probably sheds considerable light on the characters of the scapula in *Daphœnus*, which is not yet known. The bone as a whole reveals a curious combination of the features of the scapula of the tiger and the bear, and shows less similarity to that of the Canidæ. As in the tiger, the bone is elongated, with sub-equal pre- and post-scapular fossæ, the coracoid border is suddenly expanded and again contracted

[15] On further excavation by the writer in the quarry where Prof. Loomis of Amherst found the skeleton, there were found various parts which belong to the Amherst specimen and will be forwarded to that institution.

before the suprascapular border is reached, and the acromion process on the spine is well developed, while the postscapular fossa is unequally divided by the prominent and sharp glenoid border, identically as in the bears. In the fox the scapula has a small area developed for the teres major muscle at the superior portion of the glenoid border, but it is quite small in comparison with that in the present genus, in which the scapula as a whole is proportionally broader transversely. The spine is high and terminates in an overhanging acromion, which, however, does not project below the glenoid cavity. Judging from the heavy acromion process there was undoubtedly a clavicle of perhaps considerable development. The glenoid cavity is not so large proportionally as in the large cats, and in this respect is rather more like that in *Canis*. The coracoid process also has about the same proportionate development as in *Canis* and is relatively much shorter than in the tiger.

Professor Scott states (*l. c.*, p. 381) that in *Cynodictis* "the coracoid process is unusually large . . ." that the "prominent acromion descends below the level of the glenoid cavity . . ." and that in general character the scapula "is rather viverine or raccoon-like than canine," which is not true of the scapula in *Daphœnodon*.

In *Temnocyon ferox*, according to Eyerman's description[16] "the greatest vertical length [of the scapula] is from the coracoid to the posterior upper edge and not along the spine, as in *C. familiaris*. This is not the case in the present genus, nor is the spine "falling short of the supra-scapular border," as in the John Day genus, but in this respect it is more nearly like the dogs.

It is interesting to note that the area for the teres major muscle on the upper part of the glenoid border of the scapula in *Hoplophoneus* is also quite large, and is quite similar to that in *Daphœnodon*.

MEASUREMENTS OF SCAPULA.

	Mm.
Greatest height from glenoid cavity to suprascapular border	167
Greatest antero-posterior diameter	104
Antero-posterior diameter of glenoid cavity, including the coracoid process	39
Transverse diameter of glenoid cavity	23

Humerus (Plate LXXIX).—The humerus has apparently changed very little in its general characters from that of the Eocene forms. The slight shortening of the bone and the less developed supinator ridge, together with the somewhat greater development of the internal epicondyle in the present form are, the only noteworthy differences from those in the Oligocene genus *Daphœnus*. The tendency to a reduction of the supinator ridge in *Daphœnodon* is a distinct step from the early

[16] Eyerman, J. The American Geologist, Vol. XVII, p. 274, 1896.

types[17] toward the recent canids, while the bone on the whole tenaciously retains features met with in the early progenitors; *viz.*, the presence of the entepicondylar foramen, the heavy deltoid ridge which extends well down on the shaft, and many other minor details.

In comparing the humerus with that of the tiger the similarity is surprisingly close, the deltoid crest of the recent form being proportionally even less developed, while the distal trochlea is transversely somewhat broader in proportion. The

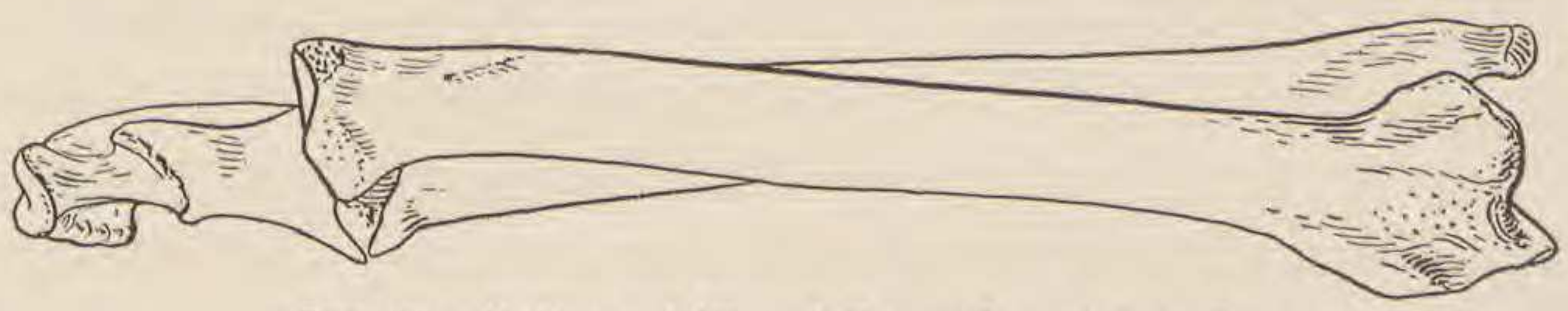

FIG. 28. Radius and Ulna of *D. superbus*. ½ nat. size.

humerus of *Amphicyon major* of Europe has also a greater transverse diameter distally and the supinator ridge is more rounded and heavier than in the genus under description.

MEASUREMENTS OF HUMERUS.

	Mm.
Greatest length	211
Antero-posterior diameter of head	52
Transverse diameter of head at tuberosities	44
Greatest transverse diameter of distal end	55
Greatest transverse diameter of distal trochlea	34
Greatest antero-posterior diameter of distal end	32

Radius and Ulna (Plate LXXIX). — The radius is proportionally longer and the humerus shorter in *Daphœnodon* than in *Daphœnus*. It is also observed that the shaft of the bone in the former genus has a less sinuous curvature than in the latter; in other respects there are only minor details of difference in the two genera, and the feline characters are practically as prominently shown in the later as in the earlier form, *i. e.*, the inner margin of the head overhangs the shaft as in the cats, the articular surface with the lesser sigmoid cavity of the ulna extends well around on the internal side of the head, and the tubercle for the biceps muscle is very prominent, while the distal end is quite broad transversely and displays well marked tendinal grooves, which, however, are not as well developed as those in the tiger.

The radius in *Amphicyon major* is also quite cat-like, though the tendinal grooves on the inner angle of the distal end are apparently less developed than in *Daphœnodon*.

[17] Wortman, J. L., "Study of Eocene Mammalia," etc., American Journal of Science, Vols. XI–XIV, p. 348, Fig 9, p. 438, 1902.

The olecranon process of the ulna is very short, truncated, and more inwardly produced than in the Oligocene genus. The tendinal sulcus, though well defined and wide, is not so deep as in *Canis lupus*, and consequently much less developed than in the cats. The principal feature of the greater sigmoid notch is its heavy coronoid process, which character is feline rather than canine. The shaft is very heavy and not much curved. The tuberosity for the flexor profundus digitorum muscle on the external border of the shaft is very heavy, as is well shown in Figs. 5 and 6, Pl. LXXIX. Distally the shaft is more trihedral in cross-section due to the sharp ridge which separates the internal and posterior surfaces as in the tiger.

The articulation for the radius on the distal end is a heavy rounded knob much as in the large cats and entirely unlike that in the dogs. The styloid process extends well down and has a decided constriction above the articulation for the cuneiform.

In *Cynodesmus brachypus* both ulnæ are represented. The olecranon process is short and truncated, the tendinal groove is deep as in *Canis*, but the coronoid process is larger in proportion than in the recent dogs, as is also the shaft. The distal end, however, lacks the heavy and broad development of the rounded tubercle which articulates with the radius and is so conspicuous in the genus under description. The feature of this reduction of the ulna in *C. brachypus* is apparently a decided step towards conditions found in *Canis*.

Measurements of Radius and Ulna.

	Mm.
Radius, greatest length	184
Radius, antero-posterior diameter of proximal end	16
Radius, transverse diameter of proximal end	23
Radius, transverse diameter of shaft medially	15
Radius, antero-posterior diameter of shaft medially	12
Radius, greatest antero-posterior diameter of distal end	23
Radius, greatest transverse diameter of distal end	34
Ulna, greatest length	223
Ulna, antero-posterior diameter at coronoid process	32
Ulna, transverse diameter at coronoid process	25
Ulna, transverse diameter of distal end at tubercle	20
Ulna, antero-posterior diameter of distal end at tubercle	11

The Manus (Pl. LXXX).—With the exception of the trapezoid the manus of the type specimen is quite completely represented. As the forefoot was found more or less disarticulated the respective positions of the phalanges as determined by the writer may be somewhat conjectural; their positions are, however, sufficiently correct for a general description.

In comparing the scapho-lunar bone with that of *Daphœnus felinus* it is found that the similarity is remarkably close. The dorsal face of the bone in the present genus has a less vertical diameter than in the Oligocene form, which is due to the fact that the articulation for the radius is carried further downward on the anterior face than in the older type, in fact lower than in the lion and tiger, consequently far removed from conditions in the recent dogs, in which the dorsal face of the scapho-lunar is very large, the bone being much higher throughout.

The articular facet for the radius also extends far downwards on the palmar face near the ulnar angle, as in the lion and tiger, which indicates that there was even more power of flexure between these two bones (radius and scapho-lunar) in the present genus than in *Daphœnus*, and is a condition strikingly similar to what is seen in the large cats. The radio-palmar process is well developed, but has not the vertical diameter seen in *Canis*, and is more nearly like that in the cats. It is, however, more distinctly separated, by a constriction, from the main body of the bone than in the felines, which is due to the greater development of the palmar face of the scapho-lunar in the latter. The ulnar face has no facet for the cuneiform, which is identical with that in *Daphœnus*, in which the cuneiform and scapho-lunar did not come in touch with one another sufficiently to establish facets. Distally there are well defined facets for the unciform, magnum, trapezoid, and trapezium respectively. The facet for the unciform is deeply excavated as in *Daphœnus*, while that for the magnum is extended downward somewhat less near the dorsal border, the beak of the lunar being less produced downward in the present genus. The facet for the trapezoid is a large, irregularly shaped, and obliquely placed surface, indicating a trapezoid of considerable size. The facet for the trapezium is located on the extreme radial angle, but is poorly demarcated from the facet for the trapezoid.

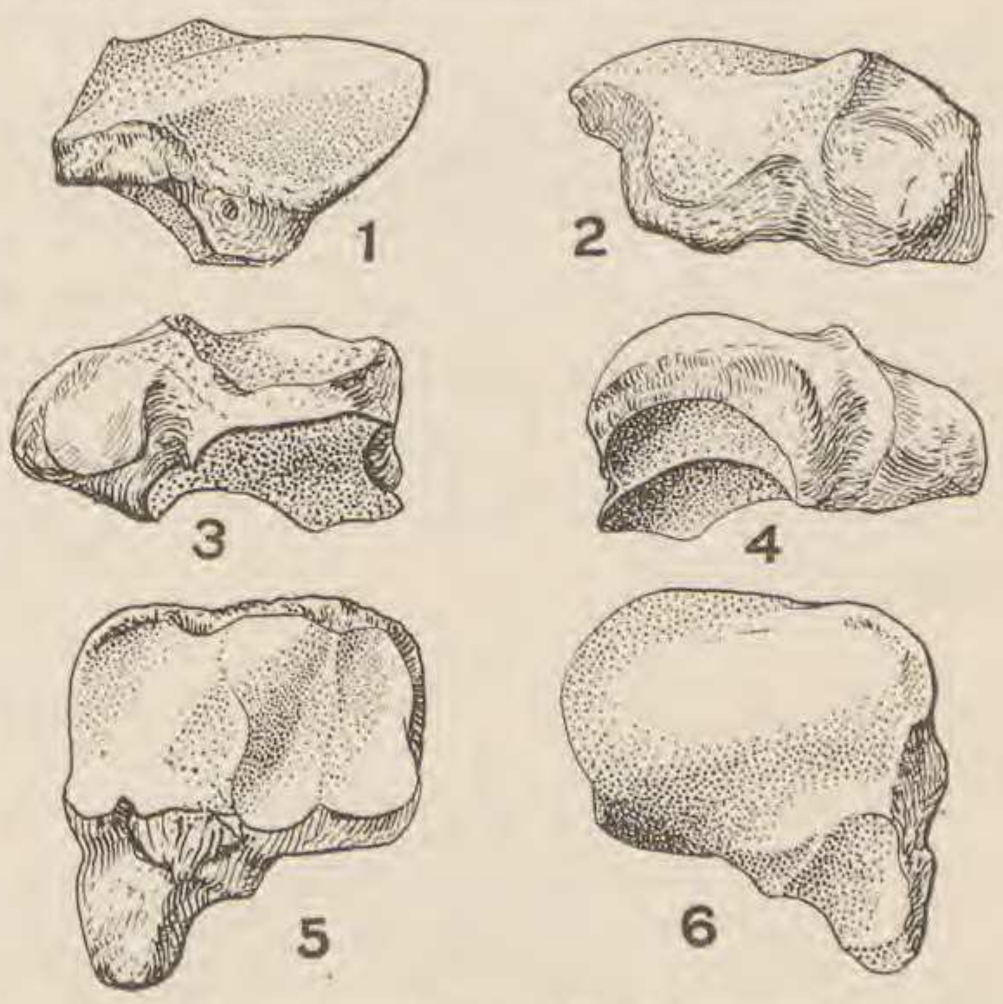

FIG. 29. Scapho-lunar (left sides) of *D. superbus*. Nat. size. 1, dorsal view; 2, palmar view; 3, radial view; 4, ulnar view; 5, inferior view; 6, superior view.

MEASUREMENTS OF SCAPHO-LUNAR.

	Mm.
Greatest antero-posterior diameter, including the radio-palmar process	29
Greatest transverse diameter	29
Greatest vertical diameter near dorsal face	19

Cuneiform.— As in *Daphœnus* the cuneiform is broad laterally, much depressed in the vertical direction, and has a large process which occupies the dorso-ulnar face of the bone, and furnishes muscular attachment for Mc.V, but does not articulate with the latter as in the dogs. The facets for the ulna and pisiform on the proximal face are subequal in size and are separated by a prominent ridge, the former being more concave antero-posteriorly than the latter. In the dogs the facet for the ulna is different, being more sinuously curved, with an antero-posterior cavity on the ulnar angle and an antero-posterior convexity on the proximo-dorsal angle of the bone. The distal face is taken up by a large facet which is concave in all directions and articulates with the unciform. The bone as a whole is not unlike the cuneiform of the tiger.

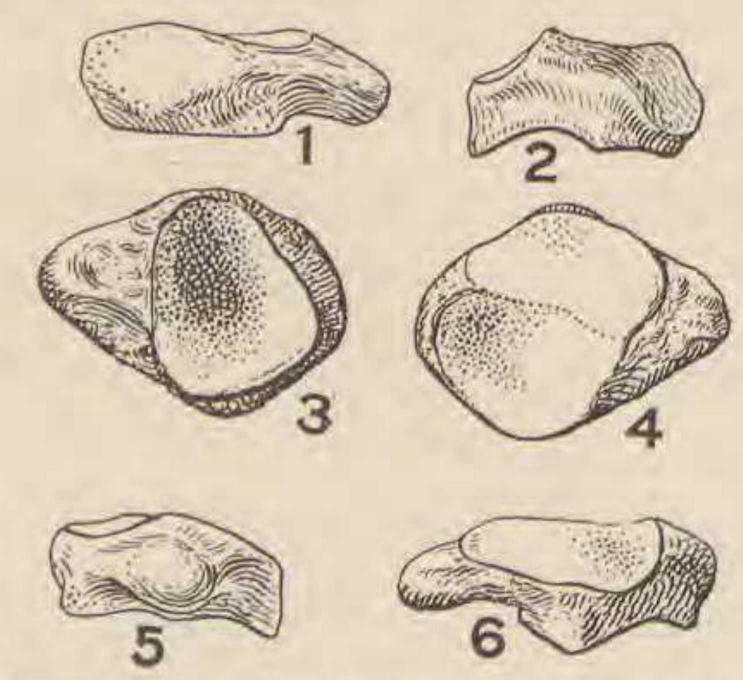

FIG. 30. Cuneiform (left side) of *D. superbus*. Nat. size. 1, dorso-ulnar view; 2, dorsal view; 3, inferior view; 4, superior view; 5, palmar view; 6, palmo-radial view.

MEASUREMENTS OF CUNEIFORM.

	Mm.
Greatest antero-posterior diameter	14
Greatest transverse diameter	20
Greatest vertical diameter of dorsal face	8

Pisiform.—In its general proportions the pisiform is quite robust; it is proportionally slightly heavier than in the tiger, but has a relatively shorter shaft. The articulations for the ulna and cuneiform are subequal in size and thus quite unlike the corresponding surfaces in *Canis*, in which the articulation for the cuneiform is much the larger of the two. As stated above the shaft is short and heavy and terminates in an expanded and truncated free end with the vertical diameter greater than the transverse.

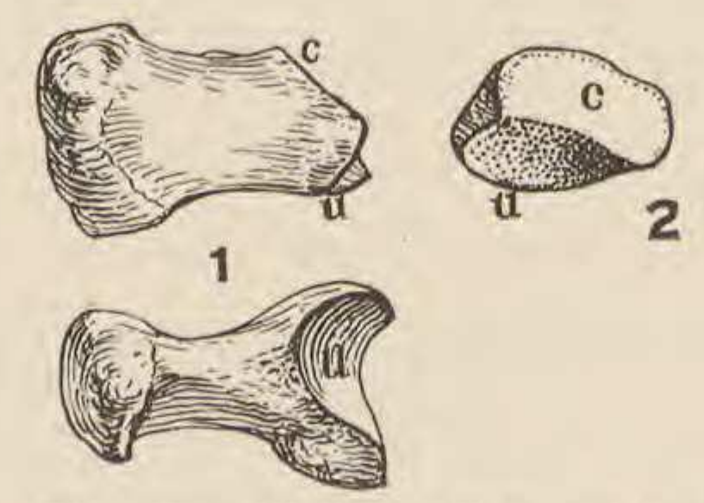

FIG. 31. Pisiform (left side) of *D. superbus*. Nat. size. 1, ulnar and superior views; 2, view of articular facets of cuneiform and ulna; *c*, *u*, cuneiform and ulna facets, respectively.

MEASUREMENTS OF PISIFORM.

	Mm.
Greatest diameter	23
Antero-posterior diameter of articular facets	14
Vertical diameter at articular facets	9
Vertical diameter at free end	14

Trapezium.—The trapezium is of moderately large size. Its dorsal or dorso-radial face is considerably exposed (when viewed from in front), and its general outlines are pentagonal, while on the palmar or postero-ulnar angle there is a heavy process for attachment of muscles. On the ulnar face is a large facet for the trapezoid, which extends well back, covering the base of the palmar process, referred to above. On the proximal radial angle there are well formed facets for the scapholunar; the one on the radial angle is scarcely separable from the one on the palmar process. Distally there is a large obliquely placed facet for Mc. I which is concave from before backwards.

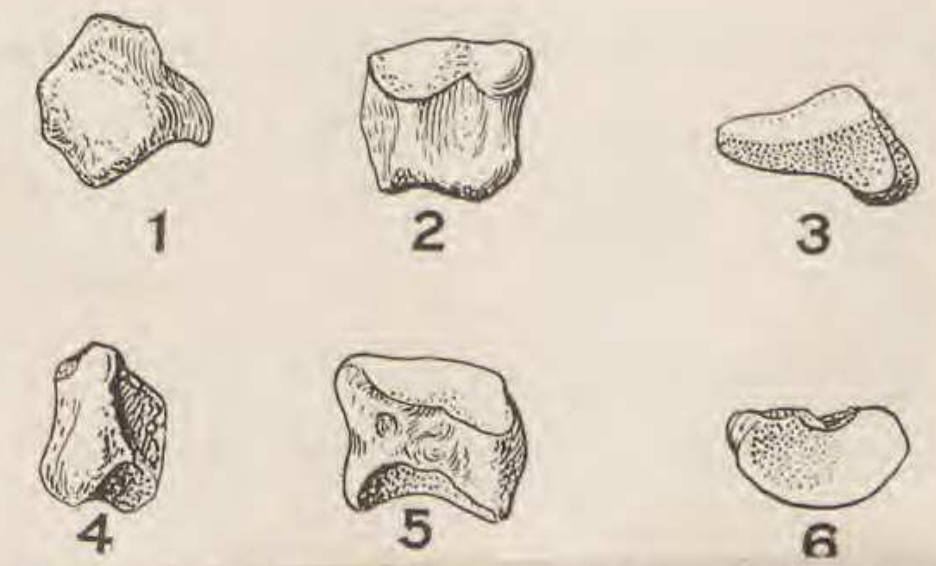

FIG. 32. Trapezium (right side) of *D. superbus*. Nat. size. 1, dorsal view; 2, radial view; 3, superior view; 4, posterior view; 5, ulnar view; 6, inferior view.

MEASUREMENTS OF TRAPEZIUM.

	Mm.
Greatest antero-posterior diameter	12
Greatest transverse diameter	7
Greatest vertical diameter	10

Trapezoid.— The trapezoid is not known, but judging from the space in the carpus when the trapezium is placed in position it would seem that the trapezoid is larger than the trapezium which is the reverse of what is seen in *Daphænus*, studied by Mr. Hatcher (*l. c.*, p. 86) and compared by the present writer.

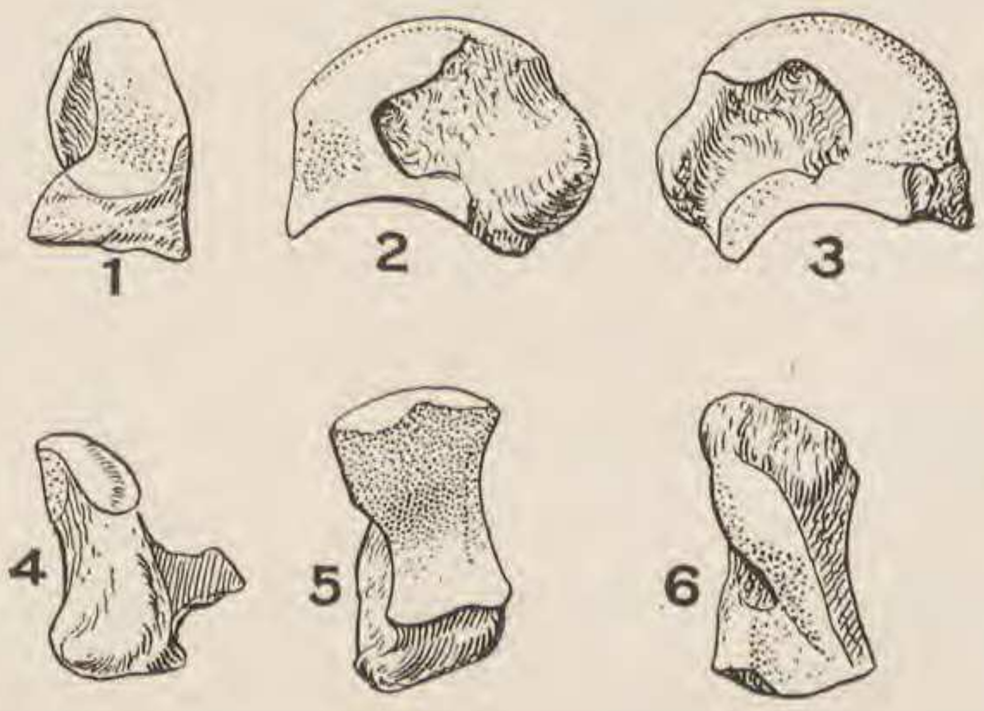

FIG. 33. Magnum (left side) of *D. superbus*. Nat. size. 1, dorsal view; 2, ulnar view; 3, radial view; 4, palmar view; 5, inferior view; 6, superior view.

Magnum.—The magnum has a small dorsal face, but is in general a much larger bone than is indicated by this surface. The dorso-radial angle has a small facet for the trapezoid and this region of the bone is much depressed, while the radial face has a great vertical diameter, due to the sharp ridge which extends upward, articulating radially with the scapho-lunar, and on the ulnar face with the unciform. In *Canis* the ulnar face has a large dorsal and a smaller palmar facet for the unciform; the two facets being separated by a deep groove, while in *Daphænodon* the facet is uninterrupted and surrounds an excavated area in the middle and posterior portions of the ulnar face. The radial face of the magnum is also deeply excavated. The palmar tuberosity is of considerable vertical diameter, while transversely it is compressed. Distally the bone is occupied by two facets, the larger for

Mc. III and the smaller for Mc. IV. In *Daphœnus* the latter facets are divided in about the same proportions as in the present genus.

MEASUREMENTS OF MAGNUM.

	Mm.
Greatest antero-posterior diameter	20
Transverse diameter of dorsal face	11
Greatest vertical diameter	16

Unciform. — The facet for the cuneiform does not extend so far down on the ulnar angle as is the case in *Daphœnus*, otherwise I cannot see any difference in the unciform in the two genera. On the dorsal face the bone has a transverse excavation and lacks the heavy convex rugosity for muscular attachments seen in the tiger, nor is the palmar tuberosity so well developed; otherwise the bones in the two forms are not greatly dissimilar. From *Canis* the unciform in *Daphœnodon* is at once distinguished by the lateral position of the facet for the cuneiform, the latter facet being more nearly superior on the bones in the true dogs. The radial face is deeply excavated by a sulcus which corresponds to the one described on the ulnar face of the magnum. Around this sulcus is a large continuous, although irregularly shaped, facet for the magnum, which is altogether different from the four separated facets for the magnum in *Canis*. Immediately above the facet for the magnum there is a second facet, which articulates with the scapho-lunar. The anterior portion of this continues into the facet for the magnum in an imperceptible manner, while further back there is a decided ridge separating the two facets. Distally the bone is entirely taken up by the large facets for Mc. IV and V.

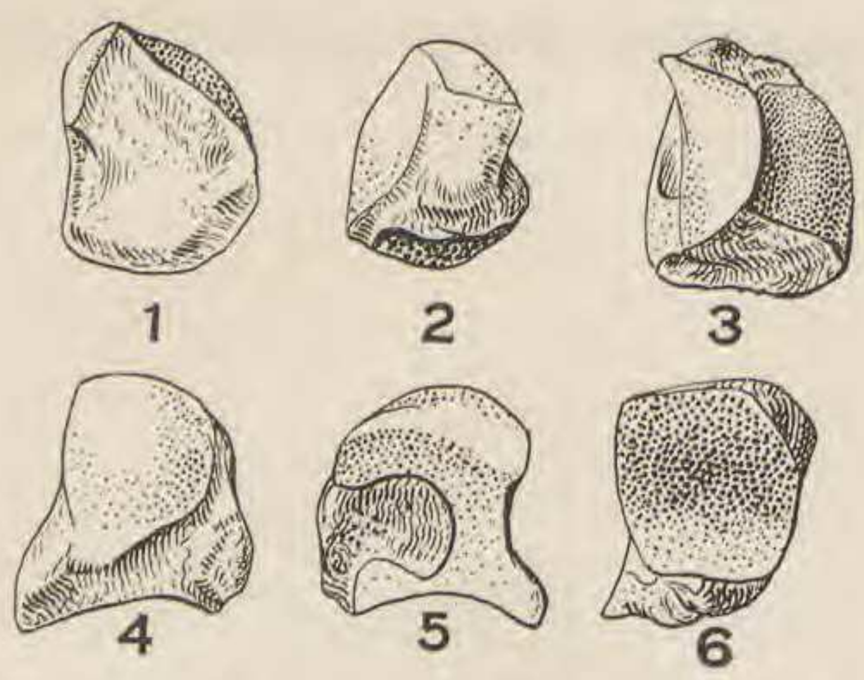

FIG. 34. Unciform (left side) of *D. superbus*. Nat. size. 1, dorsal view; 2, palmar view; 3, superior view; 4, ulnar view; 5, radial view; 6, inferior view.

MEASUREMENTS OF UNCIFORM.

	Mm.
Greatest antero-posterior diameter	16
Greatest transverse diameter dorsally	13
Greatest vertical diameter	17

Metacarpal I. — In their general characters the metacarpals are feline rather than canine. The first metacarpal is of approximately the actual length of that in an adult specimen of *Canis lupus*, but it is heavier, its proximal end is more expanded, and the articulation for the trapezium is broader. In comparative size the bone is very little smaller than in *Daphœnus* and consequently much heavier and longer than in *Canis*. On the ulnar face the rugosity for the ligamentary attachment to Mc. II is quite prominent and the tuberosity on the radial side of the head is as large proportionally as in recent cats, though the bone as a whole however, is, lighter and longer than Mc. I of the pollex in the latter. The distal end has a well formed facet which is separated palmarly by a prominent keel. The shaft is slightly curved, so that the distal end points a little in the ulnar direction.

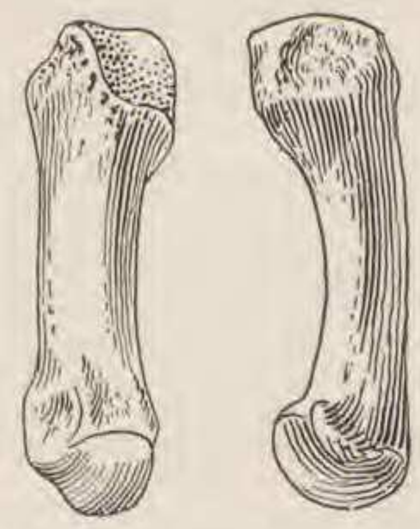

FIG. 35. Dorsal and Radial Views of Left Metacarpal I of *D. superbus*. Nat. size.

MEASUREMENTS OF METACARPAL I.

	Mm.
Greatest length	32
Greatest antero-posterior diameter of head	10
Greatest transverse diameter of head	11

Metacarpal II. — While the actual length of the first metacarpal is equal to that in *Canis* the second, third, fourth, and fifth are much shorter. This gives a characteristically low and broad appearance to the manus, as in *Meles* or perhaps even more similar to that in *Arctictis*. Thus the second and fifth are of subequal length and are considerably shorter than the third and fourth. The head of Mc. II has the antero-posterior diameter much greater than the transverse, which is due to the comparatively small extent in the ulnar direction of the flange which carries the facet for Mc. III. In the cats this flange is very prominent on Mc. II and III, and forms a more completely interlocking condition of the metacarpals than is seen in the present genus and in the recent dogs generally. The shaft is subcylindrical in cross-section and strongly arched in the dorsal direction. The distal end is suddenly expanded and the trochlea is more cat- than dog-like.

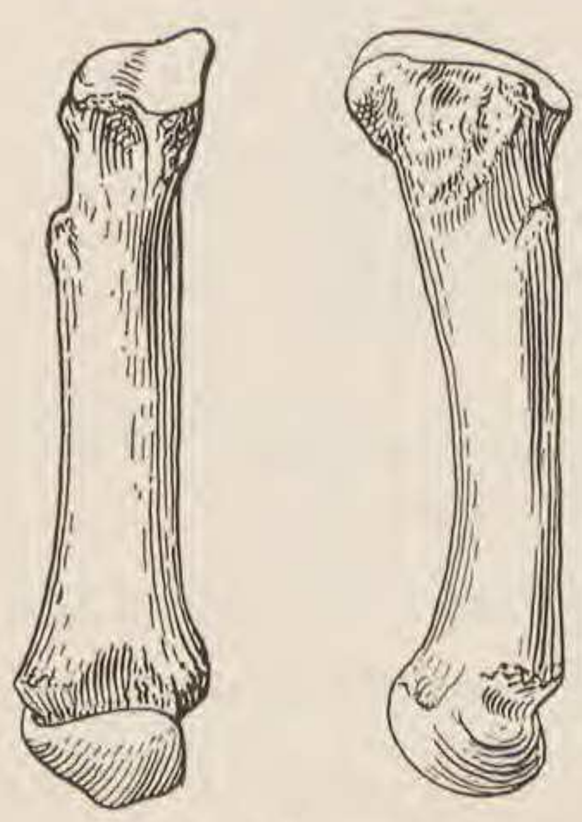

FIG. 36. Dorsal and Radial Views of Left Metacarpal II of *D. superbus*. Nat. size.

MEASUREMENTS OF METACARPAL II.

	Mm.
Greatest length	51
Greatest antero-posterior diameter of head	16
Greatest transverse diameter of head	16

Metacarpal III. — The third metacarpal is slightly longer than the fourth and is consequently the longest in the series. The proximal articulations of this metacarpal as well as all the others are so placed that when articulated the distal ends spread very much more than in the recent dogs. This is also true of the metacarpals in *Daphœnus.* As in the latter genus the dorsal face of the proximal end has a rugose excavation for tendinal attachments, while that area in *Canis* is raised higher up and in place of the excavation there is a considerable eminence. On Mc. III in *Cynodesmus brachypus* this eminence is also well developed. The shape of the different facets of the proximal end are identical with those in *Daphœnus; i. e.*, the facet for the magnum is narrow and deep, that for Mc. II larger and more oblique

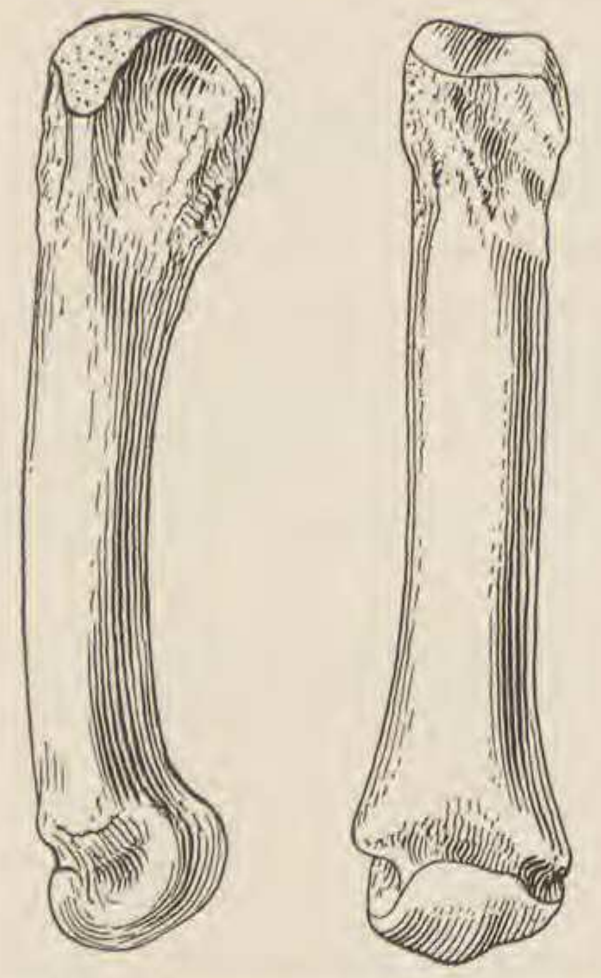

FIG. 37. Dorsal and Radial Views of Right Metacarpal III of *D. superbus.* Nat. size.

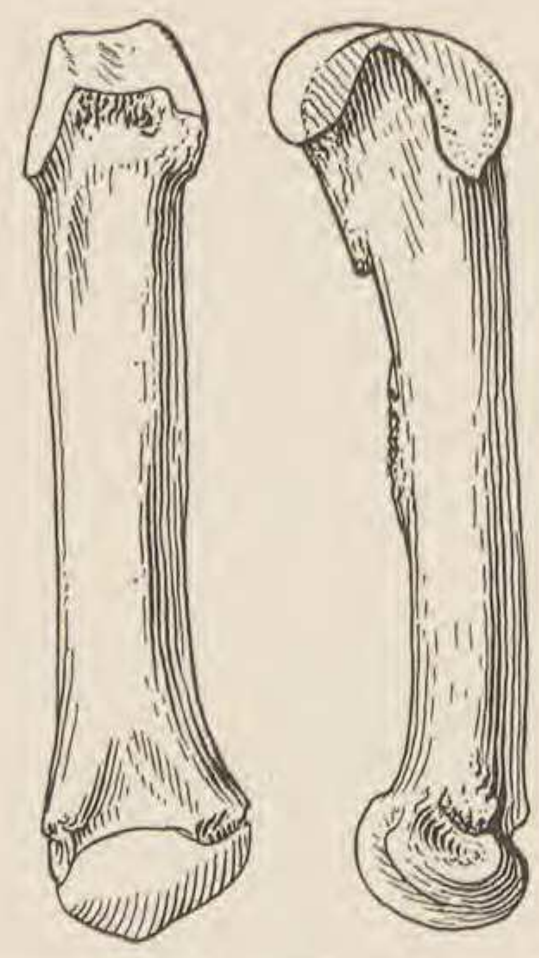

FIG. 38. Dorsal and Radial Views of Right Metacarpal IV of *D. superbus.* Nat. size.

than in *Canis*, and the facet for Mc. IV larger and more angular near the proximal border. As in Mc. II the shaft is round and arched forward. The distal trochlea is narrower than in the dogs and the dorsal portion is more spherical, while the carina is very prominent.

MEASUREMENTS OF METACARPAL III.

	Mm.
Greatest length	62
Greatest antero-posterior diameter of head	14
Greatest transverse diameter of head	11

Metacarpal IV. — The general features of the head of Mc. IV are not unlike those of the third. The shaft, in fully adult forms however, is, characterized by the prominent rugosity for tendinal attachment on the ulnar angle, while in young individuals it is less noticeable. The shaft is arched in the dorsal direction and the distal end is similar to that of Mc. III.

MEASUREMENTS OF METACARPAL IV.

	Mm.
Greatest length	60
Greatest antero-posterior diameter of head	15
Greatest transverse diameter of head	12

Metacarpal V.—The fifth metacarpal is as heavy as the fourth, but it is shorter, as has been stated before. The proximal end is much expanded, especially in the ulnar direction, which is due to the heavy and rough tuberosity for the attachment of ligaments and muscles. The articulation for the unciform is regularly convex from before backward, the transverse diameter of the palmar area being greater than that near the dorsal face. In *Daphœnus* this articulation is proportionally broader, but the ulnar face of the head is not as prominently developed as in the genus under consideration (see Fig. 39). The dorsal face of the shaft faces to the ulnar side of the manus as well as forward, and the shaft is arched forward in approximately the same proportion as that of Mc. I. The distal end is expanded and points slightly in the radial direction when the bone is in position in the manus. The articulation for the proximal phalanx is similar to those on the metacarpals described above, except that the facet on the ulnar side of the palmar carina is placed higher up and is of larger size than the one on the radial side.

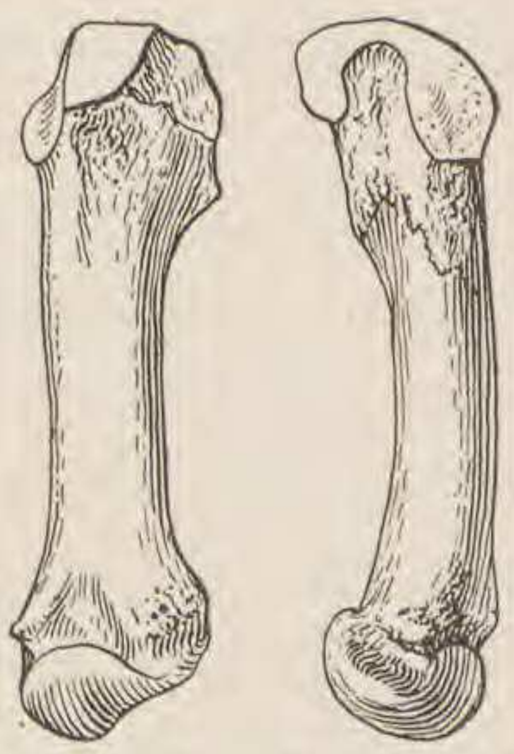

FIG. 39. Dorsal and Radial Views of Left Metacarpal V of *D. superbus*. Nat. size.

MEASUREMENTS OF METACARPAL V.

	Mm.
Greatest length	47
Greatest antero-posterior diameter of head	13
Greatest transverse diameter of head	13

Phalanges.—The proximal phalanges are proportionally somewhat shorter than in the Oligocene genus, otherwise they bear a close similarity in every respect. They are broad, depressed, strongly arched in the dorsal direction, comparatively gently convex dorsally, and rather flat on the plantar faces. The proximal ends are deeply pitted for the distal ends of the metacarpals and the tubercles for ligamentary attachments are very prominent. The distal trochlea is well formed, but is confined almost entirely to the plantar face.

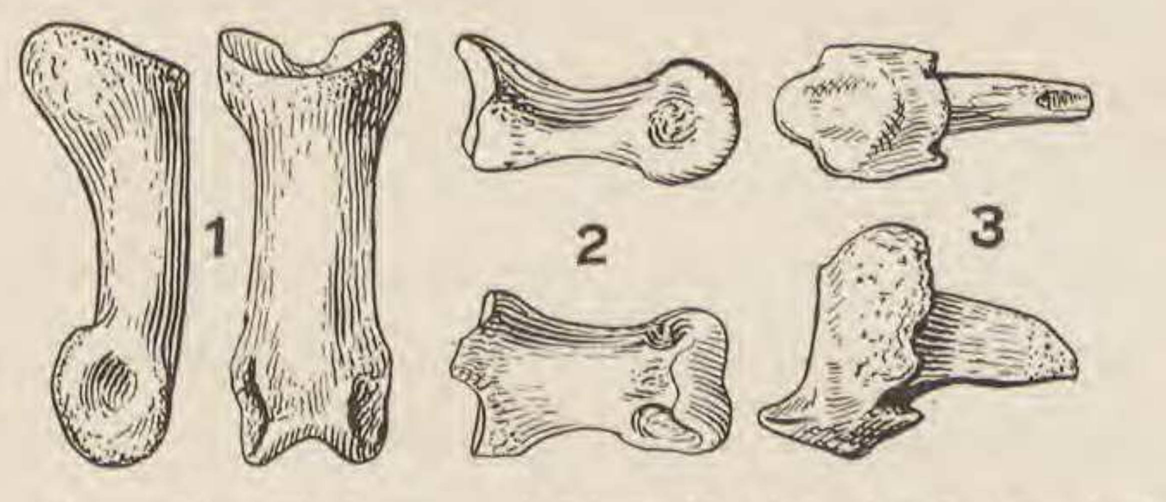

FIG. 40. Phalanges of Digit V (left forefoot) of *D. superbus*. Nat. size. 1, dorsal and radial views of first phalanx; 2, dorsal and radial views of second phalanx; 3, plantar and radial views of terminal phalanx.

The phalanges of the second row are also proportionally shorter than those in the older genus, but display the same curious depression and asymmetrical outlines. Perhaps the most curious feature of these phalanges are their articulations with the terminal phalanges. In the dogs these articulations are decidedly concave from side to side and convex from the dorsal to the plantar faces, while in the present form they are very much less concave in the plantar region and inclined to be convex from side to side at the dorsal faces, like those in the cats.

The ungual phalanges are high, not very long, and compressed laterally. There is a plainly marked groove on the plantar faces near the distal ends of the claw-plates. The latter rise to a sharp ridge dorsally and are of slightly greater transverse diameter on the plantar faces. Proximally the claw-plate is surrounded by a heavy hood, which terminates palmarly in a heavy mass together with the subungual process. The latter extends well back under the distal articulation of the middle phalanx, when articulated with the latter, and supported a strong tendon of the flexor profundus digitorum. Dorsally the hood does not project backward so as to overhang the articulation for the median phalanx as in the cats, but the hood in this region is nevertheless of considerable size and has apparently a rugose area for the attachment of some retractal ligaments. The articulation for the median phalanx is biconcave as in the felines.

After a careful study, there does not seem to be any reason to doubt that this animal had some power of retracting its claws, and in this respect it is identical with *Daphœnus*.

In *Amphicyon major* Mc. III? is proportionally short, the shaft is more greatly arched dorsally, the palmar tuberosity is heavier and the distal trochlea is more hemispherical on the dorsal face than in *Daphœnodon*, which altogether gives even a more feline look to the manus, so far as we know it, in the European species. In *Cynodesmus brachypus* the only bones present which represent the manus are the magnum and Mc. III. The former is decidedly more canine in character than the corresponding bone in *Daphœnodon*, being less depressed in front, having the ascending ridge, which articulates with the scapho-lunar, of much less vertical and greater transverse diameter, and the distal articulation more sharply notched on the radial border. Mc. III in *Cynodesmus* is shorter and lighter than in *Canis latrans*, but the bone is otherwise quite like the latter, especially the proximal end, while its length is about 12 mm. shorter than in *Daphœnodon* and also considerably lighter. A second phalanx, which undoubtedly belongs with the type of *Cynodesmus brachypus*, is quite depressed, but its distal trochlea is concave from side to side and convex from in front backward, as in *Canis*.

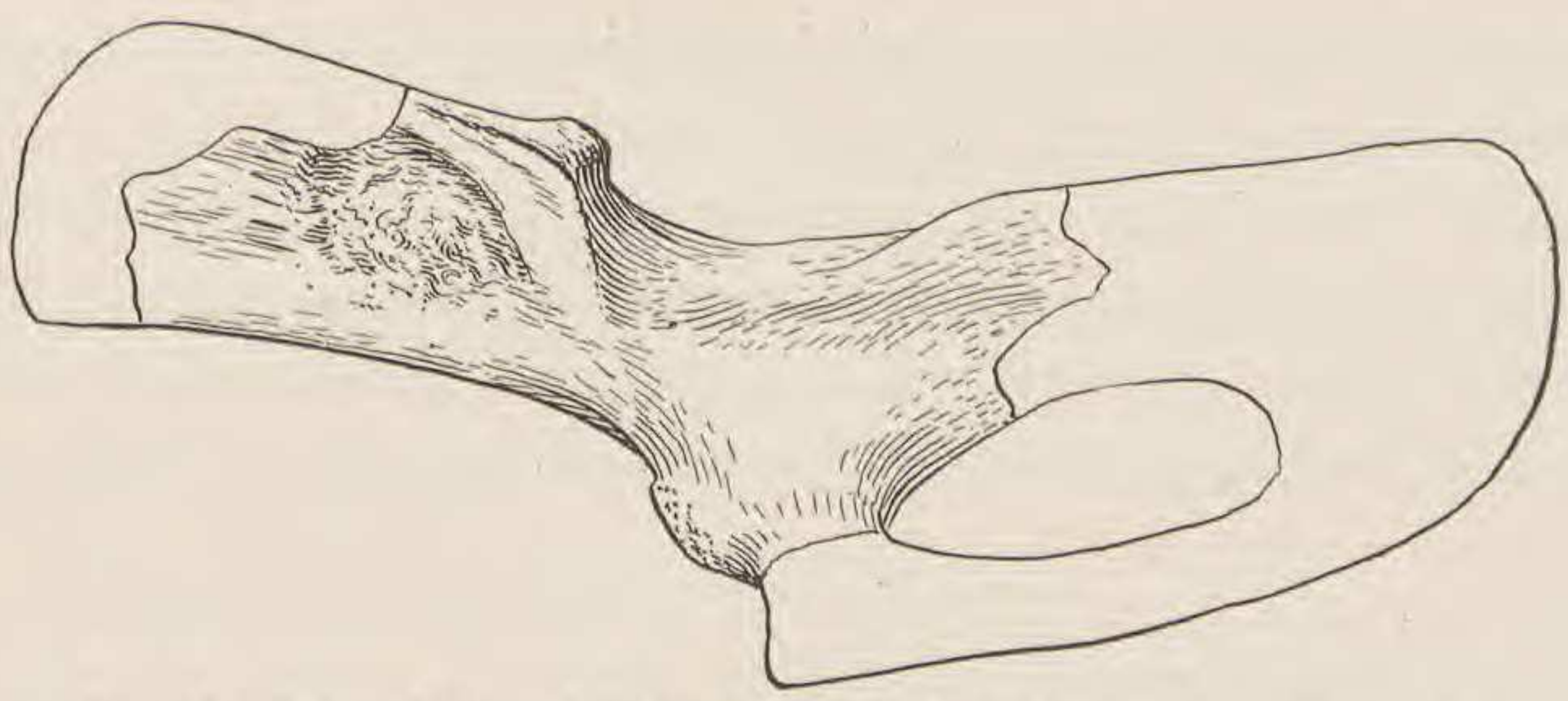

FIG. 41. Internal View of Right Half of Pelvis of *D. superbus.* ½ nat. size.

THE HIND LIMB.

(Plate LXXVIII and Plates LXXXI–II.)

The pelvis of the type is represented by the greater part of the ilium, while the ischium and pubes are represented only by the portions surrounding the acetabulum. In a larger specimen of *Daphœnodon* which belongs to the Amherst College the innominate bone is more nearly complete (see Pl. LXXVIII), but the posterior portion of the ischium is also lacking in this specimen.

In comparing the pelvis with Professor Scott's description of that in *Daphœnus* (*l. c.*, pp. 349–350) it is evident that the similarity in the two genera is quite close. As in the Oligocene genus the gluteal surface of the ilium is divided by a prominent longitudinal ridge, unlike that in recent dogs, or cats where the surface is more evenly concave. The ilium is less expanded at the supra-iliac border than in *Canis*, but probably somewhat more so in comparison with that in *Daphœnus*. The ilium, as a whole, is relatively broader than in the tiger or lion, and is not unlike that in *Viverra zivetta*, as was also observed by Professor Scott in his study of *Daphœnus*. The attachment for the sacrum is quite heavy and is situated well back. The ischial border and the great sacro-sciatic notch is short. The iliac surface is not well defined on account of the short pubic border; the ilio-pectineal eminence however, is, well developed. The acetabular border is very prominent and terminates in a large tubercle at the anterior border of the acetabulum. The latter is of moderate size and depth, the center of the floor being occupied by a large depressed and roughened area, which indicates the attachments of a large cushion of fat as well as the ligamentum teres of the femur. The cotyloid notch is quite broad and excavates the ischium deeply.

As in *Daphœnus* the ischium is long in proportion to that in the recent dogs and even longer proportionally than in the tiger or lion; the obturator foramen consequently has a more oblong outline than in the above mentioned genera and the pelvis as a whole has a greater length.

In *Cynodesmus brachypus* the pelvis is practically complete and again displays characters which are entirely unlike those in *Daphænodon* and are more like those in the recent canids. The ilium, while not as much expanded at the supra-iliac border as in *Canis*, has a tendency to become more generally concave on the external face, the attachment for the sacrum is more anterior, and the ischium and pubes are decidedly shorter than in the genus under description.

MEASUREMENTS OF PELVIS.

	Mm.
From supra-iliac border to acetabulum, approximately	105
Width of ilium at posterior inferior spine	41
Width of ilium at great sacro-sciatic notch	30
Antero-posterior diameter of acetabulum	28
Vertical diameter of acetabulum	25

Femur (Pl. LXXXI). — The femur of the type is not represented except by surface fragments which may or may not belong to this individual. The younger specimen (No. 1589a) which was found with the type has the shafts of both femora with the proximal ends lost and the distal ends slipped off at the epiphysial sutures (see fig. 42). A third and larger specimen, which belongs to Amherst College, has the femur well preserved. This complete femur will here be used in connection with the description of the type and the material of the younger individual in the Carnegie Museum (see Pl. LXXXI, figs. 1 and 2).

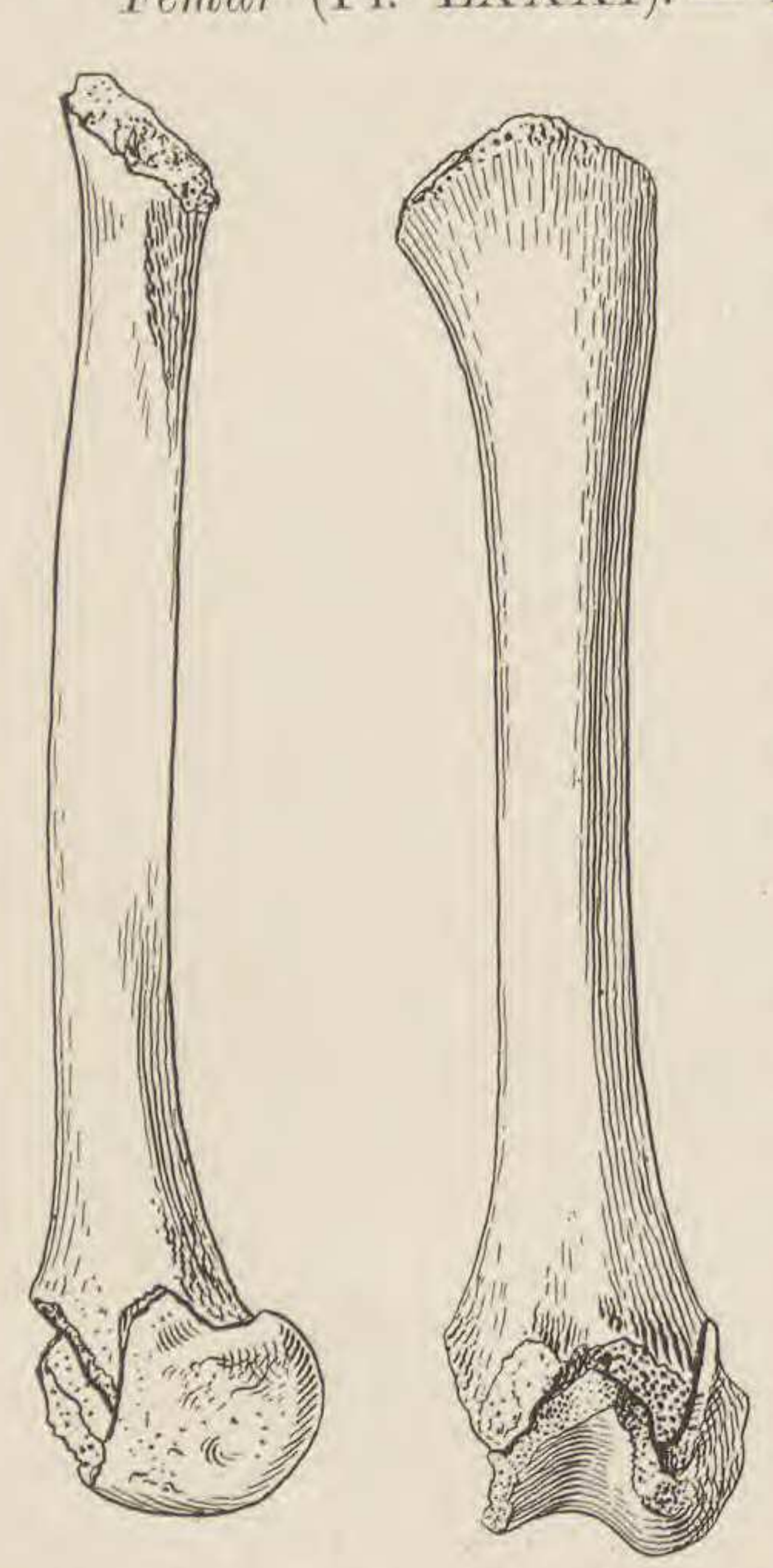

FIG. 42. Dorsal and Fibular Views of Left Femur of Young Individual No. 1589a. ½ nat. size.

The length of the femur cannot be accurately ascertained, but I judge that it is approximately equal to that in an adult specimen of *Canis lupus*. The head is rather small and hemispherical, and the neck is moderately long. The pit for the ligamentum teres is deep and located on the posterior half of the head nearer the inferior than the superior border. When the bone is held in position the head is directed upward and inward in approximately the same proportion as is the case in the recent dogs, and as is also the case in *Daphænus*. The transverse bridge from the head to the great trochanter is quite heavy on its posterior face, which causes the digital fossa to appear quite narrow transversely and crowded over to the fibular side of the posterior face. The fossa is not very deep and is partly surrounded by the great trochanter. The latter is not as prominent as in *Canis*, which may be due to individual variation, as I find in the Amherst specimen that the digital fossa and greater trochanter are more nearly of the proportionate size seen in the recent form. The lesser trochanter is prominent and located on the posterior face near the tibial angle as in *Canis*, while in the Amherst specimen it is situated more directly posteriorly. These differences may be due to individual or possibly to specific variations. The third trochanter is not present; while in *Daphœnus* it is apparently represented, though small; in fact Mr. Hatcher in his description[18] did not regard this eminence as being the third trochanter, but in his illustration (*l. c.*, Pl. XIX, fig. 1) he faithfully indicates the tubercle as it appears on the specimen. Dr. Eyerman definitely states that *Daphœnus* has a third trochanter,[19] while Professor Scott[20] did not have material of this genus sufficiently complete to fully demonstrate its presence or absence. The shaft of the young individual referred to above is rather slender, which is due to the immaturity of the animal and must not be regarded as an established character. The shaft of the Amherst specimen is long, slender, arched forward, and has a very prominent and rugose ridge on the fibular angle, which extends nearly throughout the entire length of the shaft, as in the lion. The linea aspera is also well defined. In No. 1589a the lower portion of the shaft broadens more gradually toward the distal end than is the case in the Amherst specimen, which again may be due to the immaturity of the specimen in the Carnegie Museum. The distal end of the latter has slipped off, as stated above, and as also indicated in the accompanying figure (fig. 42). The condyles in No. 1589a are moderately expanded laterally and posteriorly, which is a feline rather than canine character, while in the Amherst specimen the condyles are well extended back of the vertical line of the shaft, as in *Canis*. These variations may possibly be due to the differences in age of the two specimens. The rotular trochlea is no wider in proportion than in *Canis*, but is somewhat shorter. The intercondylar notch is quite deeply excavated and slightly oblique in position.

Patella. — This bone is not very well represented in the material of the Carnegie Museum. One patella which was found among the surface fragments is proportionately narrower and thicker than that bone in *Daphœnus* and, though larger, is quite similar to that in *Canis*.

[18] "Oligocene Canidæ," Memoirs Carnegie Museum, Vol. I, pp. 88–89, 1902.

[19] American Geologist, Vol. XIII, p. 279, 1896.

[20] Trans. Amer. Philos. Society, Vol. XIX, p. 350, 1898.

Tibia (Pl. LXXXI). — The tibia is represented by the distal ends and the greater portions of the shaft of the right and left, but the proximal ends were unfortunately broken off and lost. The shaft is rather heavy and was apparently quite short. The cnemial crest extends well down and the shaft immediately below this crest becomes triangular in cross-section, with the acute apex of the triangle directed forward. The areas for the different muscles are well defined by distinctly marked ridges, the one on the posterior face which separates the flexor longus digitorum from the flexor longus hallucis being especially prominent. On the distal end the groove for the tendon of the tibialus posticus is well developed, and the internal malleolus is very large as in *Daphœnus*. The astragalar articulation is not so deep as in the recent dogs; it is also more oblique, and does not have the transverse sulcus which interrupts these facets in *Canis*. On the fibular face is a well formed facet for the distal end of the fibula.

MEASUREMENTS OF TIBIA.

	Mm.
Greatest length, approximately	200
Antero-posterior diameter of shaft at lower end of cnemial crest	25
Transverse diameter of shaft at lower end of cnemial crest	17
Greatest antero-posterior diameter of distal end	19
Greatest transverse diameter of distal end	34

Fibula (Pl. LXXXI). —As in the tibia the proximal end of the fibula is also broken off and lost. In proportion the shaft is somewhat more slender than is the case in *Daphœnus*, and has a double curvature; its proximal portion sweeping toward the shaft of the tibia, while more distally it again curves outward and presents a rather short arch before meeting the articular facet for the tibia. As on the latter bone the surfaces for the different muscles are well defined by prominent ridges. The distal end is much expanded. The groove for the peroneus longus is well defined, as is also that for the peroneus brevis and tertius. The two grooves are separated by a prominent tubercle (outer malleolus) similar to that in the lion and quite unlike that in *Canis* where the groove for the peroneus brevis and tertius is very much less developed and the malleolus enlarged. On the tibial face there is a large round facet for the astragalus, which is gently convex in all directions. Immediately above this large facet for the astragalus is a smaller facet for the tibia, which is plane and fits perfectly against a corresponding facet on the external face of the tibia.

MEASUREMENT OF FIBULA.

	Mm.
Greatest length, approximately	190
Antero-posterior diameter of distal end	19
Transverse diameter of distal end	10

Pes (Pl. LXXXII). — The right hind foot of the type was found almost completely articulated. Consequently there is practically no doubt as to the true position of each bone in the pes.

Astragalus. — While the main features of the astragalus are in general quite similar to those in *Daphœnus felinus* there are some detailed differences which are of considerable importance, and which mark the transition from the conditions found in the older type to the more modified structures in the recent forms. It is seen that the articular trochlea for the tibia is more perfectly grooved in the present genus than in *Daphœnus*, the internal and external condyles being more nearly subequal, as in *Canis.* The articulation of the tibial face of the internal condyle, however, is, widely interrupted by a broad vertical sulcus, which is not present in the recent form, nor does it entirely bisect this articulation on the astragalus of *Daphœnus*, while in the tiger there is a similar broad area on the inner side of the internal condyle. The neck is relatively shorter, though constricted as in *Daphœnus*, which is due to the laterally expanded head, as in the cats. The head is inclined sharply inward and on the distal face is a large facet for the navicular, which is convex in all directions. The calcaneal facets are separated by a deep, narrow groove, and are subequal in size, the external being more oblique and less strongly concave than in *Canis.* In the latter genus there is a minute articular facet for the calcaneum on the fibular face of the head. In the present genus this small facet is also present, but instead of articulating with the distal end of the calcaneum, as in the dogs, it comes in contact with the dorso-tibial angle of the cuboid, as in *Daphœnus felinus.*

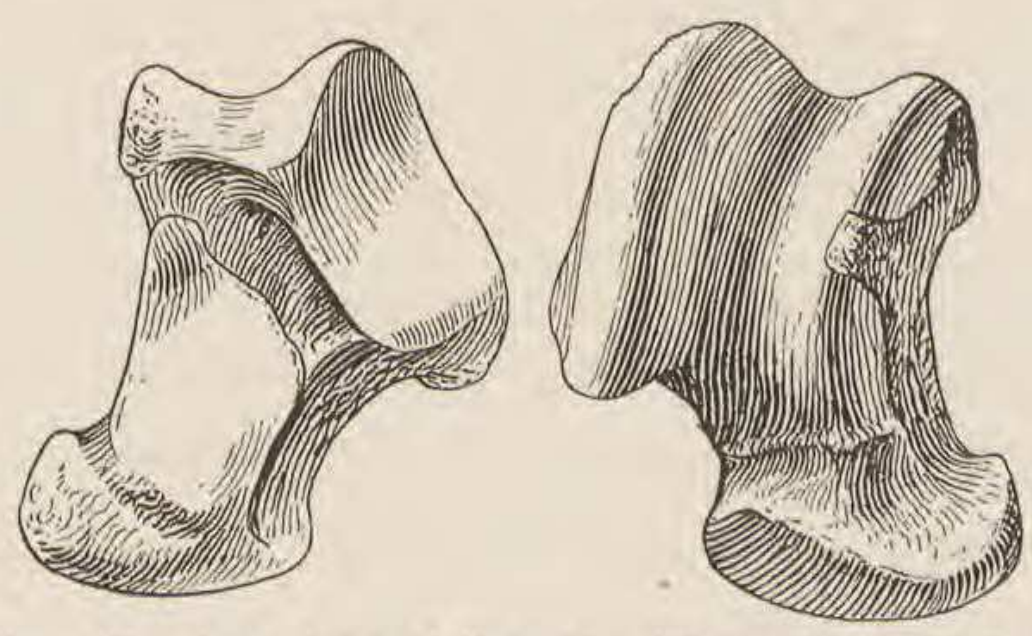

FIG. 43. Anterior and Posterior Views of Astragalus of *D. superbus.* Nat. size.

MEASUREMENTS OF ASTRAGALUS.

	Mm.
Greatest height	38
Transverse diameter of trochlea	21
Transverse diameter of head	21
Antero-posterior diameter of head	12

Calcaneum. — On comparing the calcaneum with that of *Daphœnus felinus* there is very little difference detected except in size. The palmar face of the tuber calcis is more concave antero-posteriorly on its upper portion and slopes more gradually toward the distal end than in the Oligocene genus, which is due to a greater developed eminence on the lower half of the palmar face in *Daphœnodon*. The free end of the tuber is suddenly expanded, especially laterally, and there is a well defined groove for the tendon of Achilles, as in *Daphœnus* and the recent dogs and cats generally. There is on the outer angle of the dorsal border a long and rugose groove, which, however, is not so deep as that in the Oligocene genus. This groove is also quite conspicuous in the recent lion, while in *Canis* it is entirely wanting. The articular facets for the astragalus are separated as usual by the groove for the interosseous ligament, the external facet being quite oblique and more gently convex antero-posteriorly than in *Canis*, while the sustentaculum is more prominent, the internal facet being slightly concave infero-superiorly and carried well over the superior edge, not unlike what is seen in *Canis*. The greater process of the calcaneum is much abbreviated, so that the head of the astragalus extends well below the distal end, as in *Daphœnus*, also observed by Mr. Hatcher (*l. c.*, p. 91). The peroneal tubercle is well developed, causing the fibular face of the bone to be quite concave supero-inferiorly. The distal end has a large facet for the cuboid, which is gently concave in all directions and pear-shaped in its general outline.

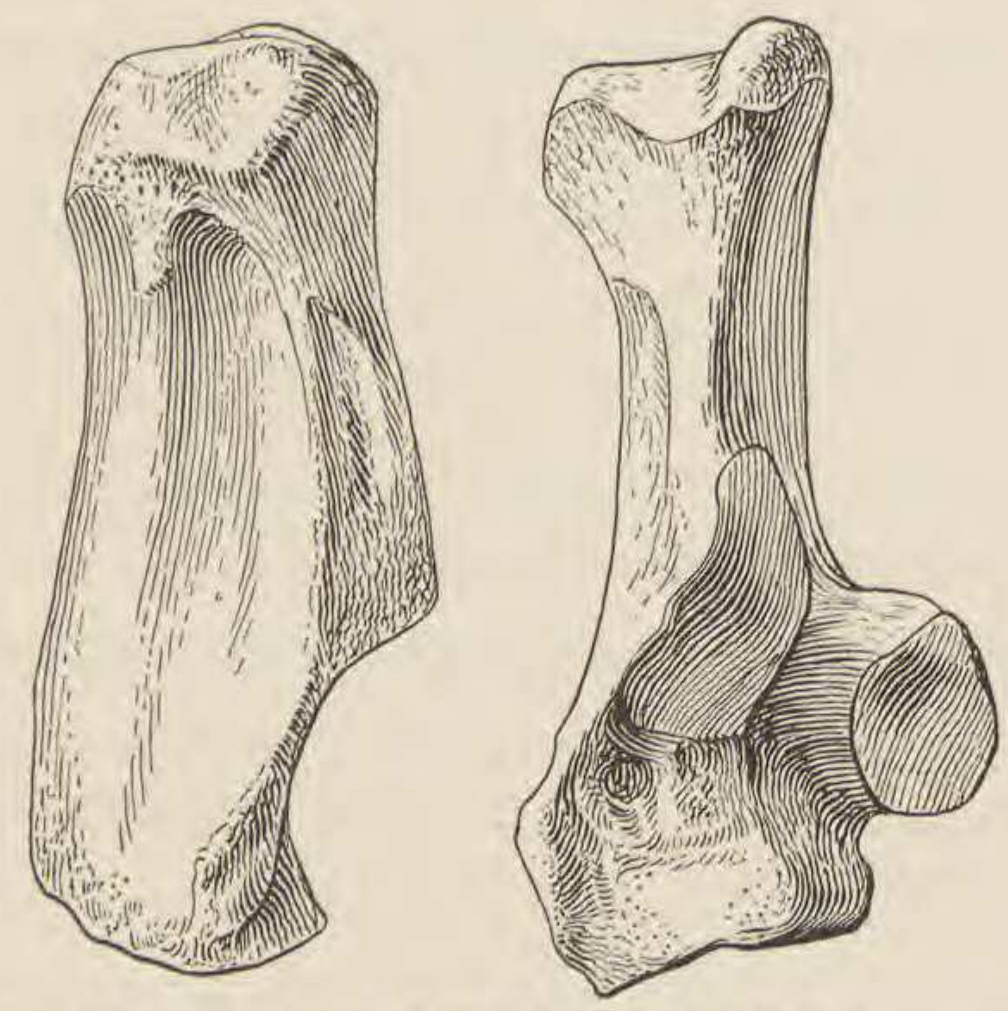

FIG. 44. Anterior and Fibular Views of Calcaneum of *D. superbus*. Nat. size.

The astragalus and calcaneum of *Amphicyon major* are represented in our collection by accurate casts, which display well marked differences from the present genus. In the first place the astragalus in the European form is broader and shorter in proportion; secondly, the head is more sessile, due to the shorter neck; thirdly, the sulcus which separates the articular facet for the tibia on the tibial face of the inner condyle in *Daphœnodon* is absent in *Amphicyon;* and fourthly, the external articular facet for the calcaneum is less concave supero-inferiorly than in the American form.

The tuber of the calcaneum in *Amphicyon* is proportionally shorter, and the palmar border is much heavier than the dorsal, while in *Daphœnodon* the two borders are subequal in thickness, as is also the case in *Daphœnus*. In the European form there is no well defined groove for the tendon of Achilles and the free end of the tuber calcis is much enlarged, as in the bears. The sustentaculum is prominent, as in *Daphœnodon*, but the greater process of the calcaneum is more abbreviated.

MEASUREMENTS OF CALCANEUM.

	Mm.
Greatest length	67
Greatest transverse diameter	33
Length of tuber from sustentaculum to free end	40

Navicular. — The navicular differs from that of *Daphœnus* by having a proportionally greater antero-posterior diameter, which is due almost entirely to the development of the palmar border in the Miocene genus. The tuberosity on the tibial face is also fully as prominent as in the Oligocene form, entirely unlike that in *Canis*, and is not dissimilar to what is found in the recent tiger or lion. The palmar face is, as stated, greatly produced, and formed into a large tuberosity, which, however, is not reduced transversely by the deep notches on the tibial and fibular sides as in *Canis*, but presents a more nearly perfect triangular outline of the entire bone when viewed from above or below. On the fibular face are two small facets, one palmar and the other dorsal. The one located dorsally is sometimes wanting, but in the type it is faintly indicated and touches the lower portion of the facet on the proximal dorsal angle of the cuboid when extreme rotation takes place, while the palmar facet articulates with a corresponding facet on the proximal palmar angle of the cuboid. The facet for the head of the astragalus is concave in the usual manner, while the facet for the entocuneiform is quite large and is not crowded posteriorly in the same degree as in *Canis* or *Felis*.

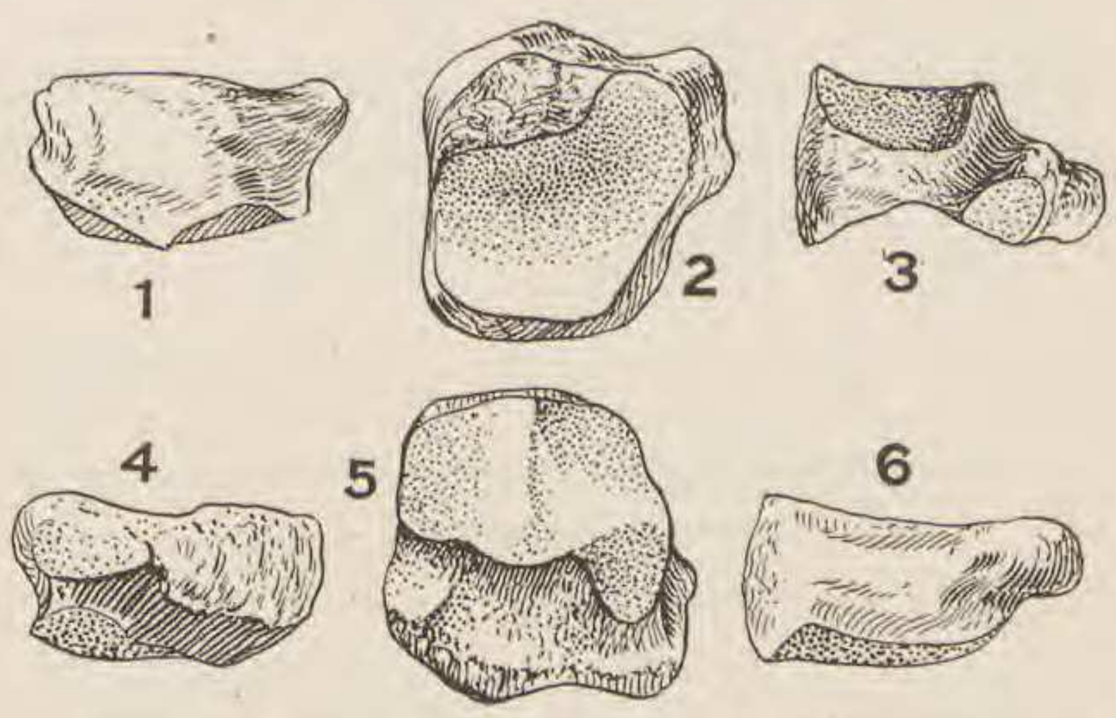

FIG. 45. Navicular (right side) of *D. superbus*. Nat. size. 1, dorsal view; 2, superior view; 3, fibular view; 4, plantar view; 5, inferior view; 6, tibial view.

MEASUREMENTS OF NAVICULAR.

	Mm.
Greatest antero-posterior diameter	21
Greatest transverse diameter	24
Greatest vertical diameter	11

Entocuneiform. — The entocuneiform, though of considerably smaller size proportionally than in *Daphœnus*, is still of large size, and occupies a more dorsal position in the tarsus than in recent forms. The bone is high, laterally compressed, having the transverse diameter greater on the plantar side than on the dorsal side, and possesses a large plantar hook, which causes the articulation for Mt. I to be

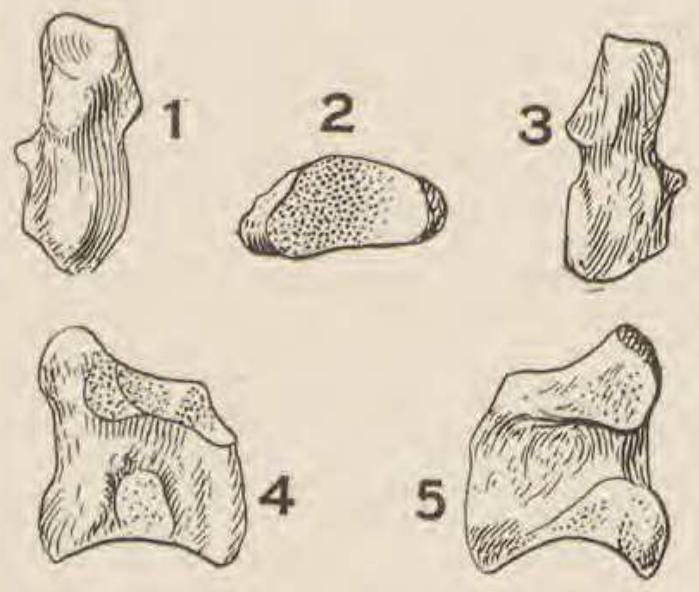

FIG. 46. Entocuneiform (right side) of *D. superbus*. Nat. size. 1, dorsal view; 2, inferior view; 3, plantar view; 4, fibular view; 5, tibial view.

quite concave in the fore-and-aft direction. The proximal articulation for the navicular ascends rapidly in the plantar region, due to a heavy process on the posterior face which points upward and backward. On the fibular face are two facets, a large one proximally for the mesocuneiform and a smaller one distally, which articulates with Mt. II.

MEASUREMENTS OF ENTOCUNEIFORM.

	Mm.
Greatest antero-posterior diameter	13
Greatest transverse diameter	7
Greatest vertical diameter	16

Mesocuneiform. — The mesocuneiform has relatively a greater antero-posterior and a lesser transverse diameter, especially of the distal face, than is the case in *Daphœnus*. Consequently the bone, which is triangular in outline when viewed from below, has a longer apex directed backward than is seen in the Oligocene genus. The facet for the navicular is slightly less oblique than in *Daphœnus*, but has the same antero-posterior concavity. On the tibial face there is a large facet for the entocuneiform which is located on the upper portion of the bone and is concave antero-posteriorly. On the fibular face, near the proximal angle, is a facet for the entocuneiform which extends throughout the entire fibular face, antero-posteriorly, but is of small vertical diameter and corresponds to a facet on the tibial face of the ectocuneiform. Distally the bone is taken up by the facet for Mt. II.

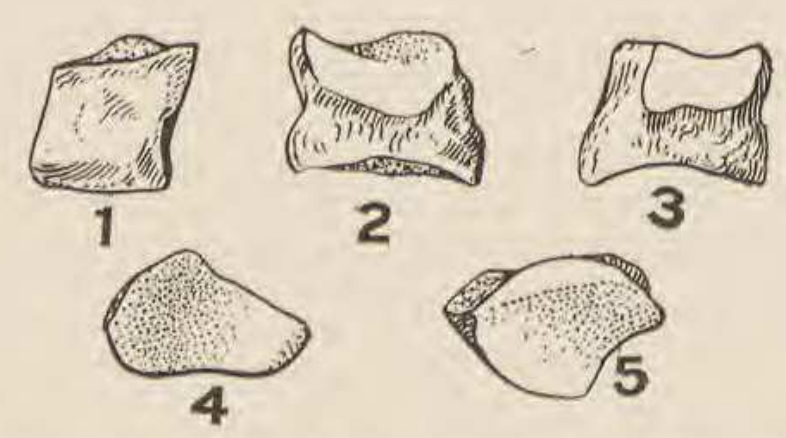

FIG. 47. Mesocuneiform (right side) of *D. superbus*. Nat. size. 1, dorsal view; 2, fibular view; 3, tibial view; 4, inferior view; 5, superior view.

MEASUREMENTS OF MESOCUNEIFORM.

	Mm.
Greatest antero-posterior diameter	13
Greatest transverse diameter	9
Greatest vertical diameter	9

Ectocuneiform. — When the ectocuneiform is compared with that of *Daphœnus* it is at once seen that this bone in *Daphœnodon* has not increased in size in the same ratio as the entocuneiform has decreased. Both meso- and ectocuneiforms are therefore of approximately the same proportionate size as in the Oligocene form. The dorsal face has a more perfect diamond-shaped appearance than in *Canis* or *Felis*, which is due chiefly to the greater obliquity of the proximal and distal articular facets in *Daphœnodon*. The facet for the navicular on the proximal face is especially oblique, due to a prominent ascending process on the fibular angle. This process has a large facet for the cuboid on its fibular face, and near the distal end there are two minute facets for Mt. IV, one dorsal and the other palmar. The tibial face has three facets, one proximally for the mesocuneiform referred to above, and two distally for Mt. II. The distal face is more oblique and also more concave antero-posteriorly than in the recent forms, while the plantar process is reduced in size and is canine rather than feline in its general characters.

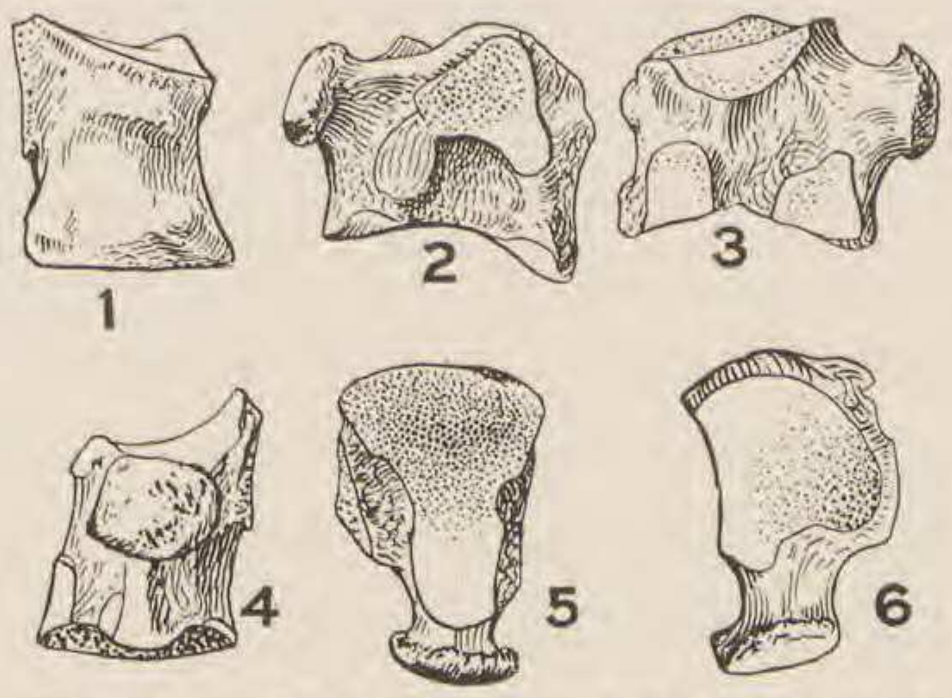

FIG. 48. Ectocuneiform (right side) of *D. superbus*. Nat. size. 1, dorsal view; 2, fibular view; 3, tibial view; 4, plantar view; 5, inferior view; 6, superior view.

MEASUREMENTS OF ECTOCUNEIFORM.

	Mm.
Greatest antero-posterior diameter	21
Greatest transverse diameter	12
Greatest vertical diameter	18

Cuboid. — In comparison the cuboid is of a slightly greater transverse and less vertical diameter than that of *Daphœnus*. Otherwise there are no striking differences in this bone in the two genera. The dorsal face is slightly concave in the proximo-distal direction, while on the fibular plantar face is found the deeply excavated groove for the peroneus longus tendon. Above this groove is a large tuberosity which forms a solid, broad, oblique ridge extending from the proximo-fibular to the distal tibial angle, and not separated by a vertical sulcus as in *Canis*. Superior to this ridge the plantar face is taken up by a large, rugose, excavated area for ligamentous insertions. The fibular face is nearly plane and has three artic-

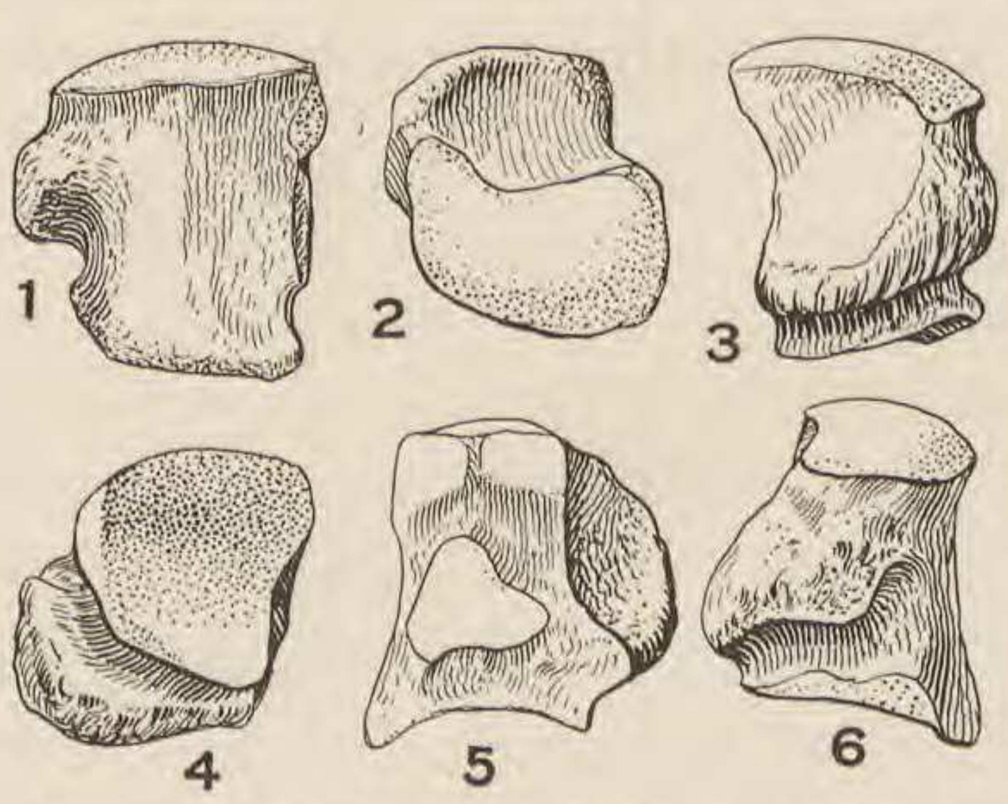

FIG. 49. Cuboid (right side) of *D. superbus*. Nat. size. 1, dorsal view; 2, superior view; 3, plantar view; 4, inferior view; 5, tibial view; 6, fibular view.

ulations; the two proximal ones are small indistinct facets which articulate, one with the head of the astragalus and the other (near the plantar surface) with the navicular. This curious feature of articulations in the tarsal bones is quite unusual and is also found in *Daphœnus* and to a less degree in *Hoplophoneus*, as Mr. Hatcher observed in his study ("The Oligocene Canidæ," p. 91). In the middle region of the tibial face is the third facet, which is of considerable size; it is triangular in outline and articulates with the ectocuneiform. Proximally the cuboid has a large surface for the calcaneum, which is convex in all directions in a greater degree than in *Canis* or *Felis* and even more than in *Hoplophoneus*, though not nearly so oblique as in the latter. Distally there is one large facet for metacarpals IV and V, which is concave antero-posteriorly and also slightly concave laterally, the extreme fibular border being slightly recurved upward to accommodate the lateral portion of the proximal facet of Mt. V.

MEASUREMENTS OF CUBOID.

	Mm.
Greatest antero-posterior diameter	20
Greatest transverse diameter	17
Greatest vertical diameter	21

Metatarsal I. — The first metatarsal has the appearance of being shorter than that of *Daphœnus* when placed in position in the pes, but it is in reality of very nearly the same proportionate length, this shortened appearance being chiefly due to the proportionally less vertical diameter of the entocuneiform in the Miocene genus. These bones (Mt. II) in the two genera are very similar in every respect. As in *Daphœnus* the head is much expanded both antero-posteriorly and transversely, with two prominently developed and rugose tubercles on the plantar face, one on the tibial and t e other on the fibular angle. The facet for the ectocuneiform is quite large and is convex antero-posteriorly, but is slightly more oblique than that of the Oligocene genus, so that the digit points more inward when the pes is articulated. The shaft is of good proportionate size and is arched forward. The distal trochlea is hemispherical on the dorsal face and on the plantar face it is divided by a strong keel. With the exception of the reduction of the entocuneiform and the position of the metatarsal there is no great change of the first digit of the pes from that of the Oligocene form, the digit on the whole being more greatly developed than in recent dogs or cats, and more resembling that of *Viverra zivetta.*

FIG. 50. Fibular and Dorsal Views of Right Metatarsal I of *D. superbus*. Nat. size.

MEASUREMENTS OF METATARSAL I.

	Mm.
Greatest length	42
Antero-posterior diameter of head	11
Transverse diameter of head	11
Transverse diameter of distal trochlea	9

Metatarsal II. — As in *Daphœnus* the articular facet for the mesocuneiform on the head of Mt. II is oblique, slightly concave antero-posteriorly, and rises to a high and sharp angle along the fibular border. The fibular side has two large facets for the ectocuneiform, thus the head of Mt. II extends above those on Mt. I and III when articulated in the foot. The plantar tuberosity is of considerable size and is located on the fibular angle. Between the plantar tuberosity and the dorsal face there is on the tibial face an excavated and rough surface, against which lies the head of Mt. I, but there is no true articular facet for the latter. The shaft is much shorter and lighter than in the corresponding bones in *Canis* or *Felis* and is in proportion to the rest of the limb perhaps more nearly like that of the bears. Distally the bone is expanded transversely, the dorsal face of the trochlea being spheroidal and the plantar face divided by a prominent carina as in the metacarpals.

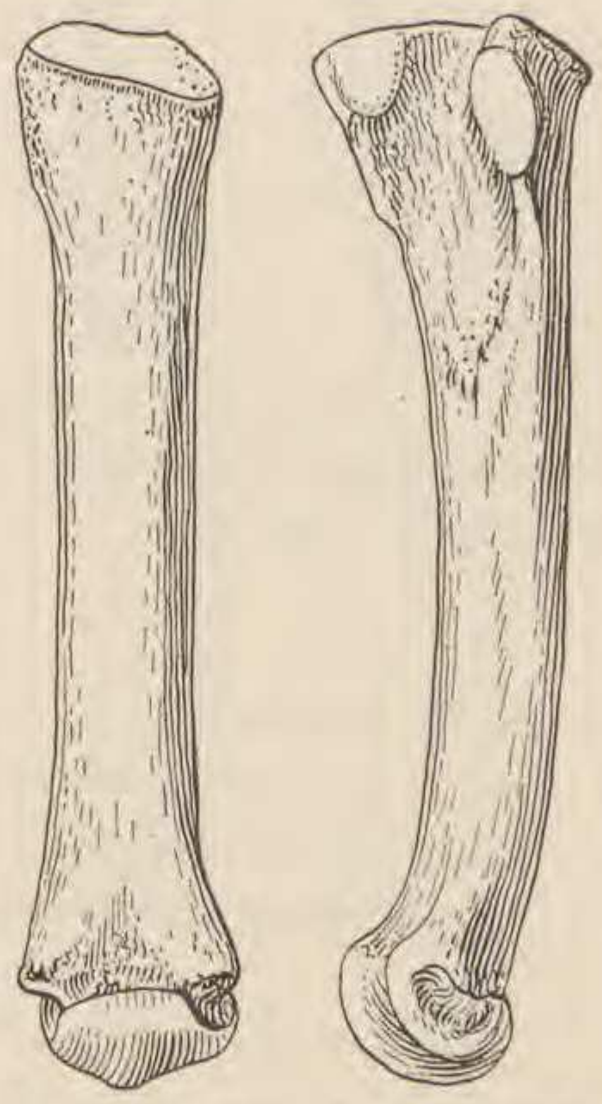

FIG. 51. Dorsal and Fibular Views of Right Metatarsal II of *D. superbus*. Nat. size.

MEASUREMENTS OF METATARSAL II.

	Mm.
Greatest length	59
Antero-posterior diameter of head	16
Transverse diameter of head	10
Transverse diameter of distal end	13

Metatarsal III. — As was observed by Professor Scott in his study of *Daphœnus* (*l. c.*, p. 356) the relative proportion of Mt. III is greater than in *Dinictis*, *Hoplophoneus* or the viverines. It is also considerably longer proportionally than Mt. II in *Canis*, while actually the bone is much shorter in the genus under description. The head has a large antero-posterior diameter, the plantar tuberosity being quite large both transversely and vertically, as in *Canis*. The articular facet for the ectocuneiform is of large size; it is quite oblique in position and is convex both antero-posteriorly and transversely. On the tibial face the head is deeply excavated, but there is no articular facet for Mt. II, except a slight area on the extreme tibial angle

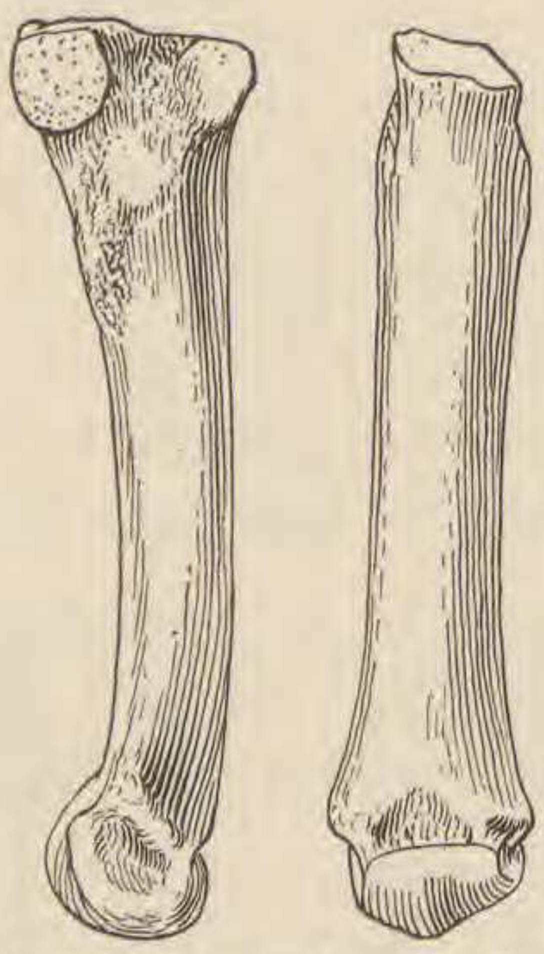

FIG. 52. Fibular and Dorsal Views of Right Metatarsal III of *D. superbus*. Nat. size.

of the plantar tuberosity. On the fibular face there are two facets for Mt. IV, which are separated by a deep sulcus. The dorsal one is located on the posterior face of the flange produced from the dorsal portion of the head, and extends in the fibular direction so as tooverlap Mt. IV, causing a strongly interlocking condition of these bones, as in the carnivora generally. The facet back of the sulcus is on the plantar tuberosity and articulates with a corresponding facet on the plantar tibial angle of Mt. IV. The shaft is quite heavy, considerably arched in the dorsal direction, and oval in cross-section. The distal end is similar to that on Mt. II, but has a more symmetrical trochlea.

MEASUREMENTS OF METATARSAL III.

	Mm.
Greatest length	70
Antero-posterior diameter of head	18
Transverse diameter of head	14
Transverse diameter of distal end	14

Metatarsal IV.—The fourth metatarsal is the longest in the series. Its head rises slightly above that on Mt. III, while the two bones extend equally far in the distal direction. The proximal face of the head has a large convex facet for the cuboid, while on the tibial side there is one facet situated on a prominent tubercle which fits into a corresponding pit on Mt. III, and the other facet for the same metatarsal is located on the plantar tibial angle, as stated above, thus causing these bones to firmly interlock, as in *Daphœnus*. On the plantar side there is a heavy tuberosity of cubical appearance and on the fibular side there is a deep pit similar to, though more pronounced than that for Mt. IV on the fibular face of Mt. III. Above this pit is a large facet which also articulates with Mt. V. The shaft is arched forward in the same degree as that on Mt. III, but is further differentiated from the latter by a prominent and rugose elevation for ligamentous attachments similar to that of *Daphœnus*. As in Mt.III the distal trochlea is quite symmetrical.

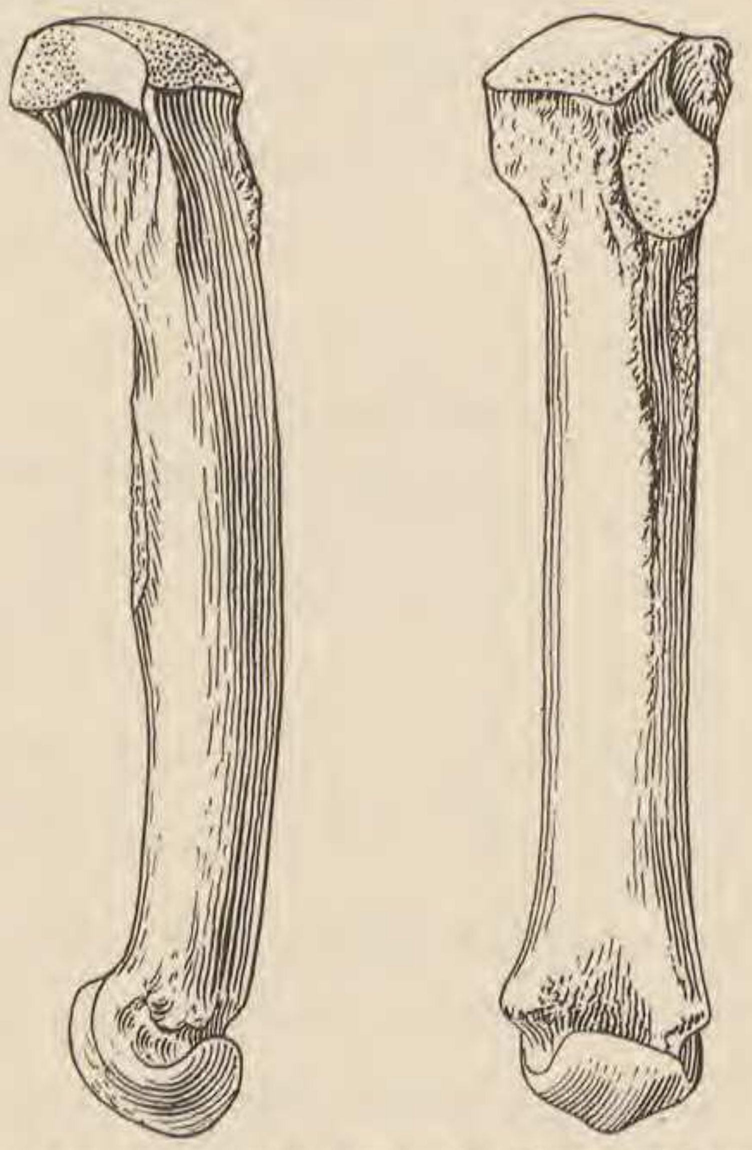

FIG. 53. Fibular and Dorsal Views of Right Metatarsal IV of *D. superbus*. Nat. size.

MEASUREMENTS OF METATARSAL IV.

	Mm.
Greatest length	73
Antero-posterior diameter of head	17
Transverse diameter of head	12
Transverse diameter of distal end	13

Metatarsal V.—The fifth metatarsal is of about the same length as Mt. II though slightly lighter. The head is greatly expanded, especially in the transverse diameter, due to the large development of the ascending fibular process, which is much more developed than in *Canis* and nearly equal in proportion to that of *Daphœnus*. On the posterior tibial side this process is succeeded by a heavy plantar tuberosity which extends throughout the remainder of the plantar face and rises above the articular facet on the proximal end. The tibial face has a projecting eminence carrying an articular facet for a corresponding pit on Mt. IV already described. The facet for the cuboid is quite large; it is slightly convex antero-posteriorly, and along the fibular border it is recurved upwards on the base of the ascending process referred to above, so that the facet is concave transversely and faces inward as well as upward like that of the older form. The shaft is well arched and has the usual transversely oval cross-section found in older types. The distal end is enlarged along the fibular border in about the same proportion as Mt. I is expanded on the tibial angle, giving the trochlea an oblique and asymmetrical appearance.

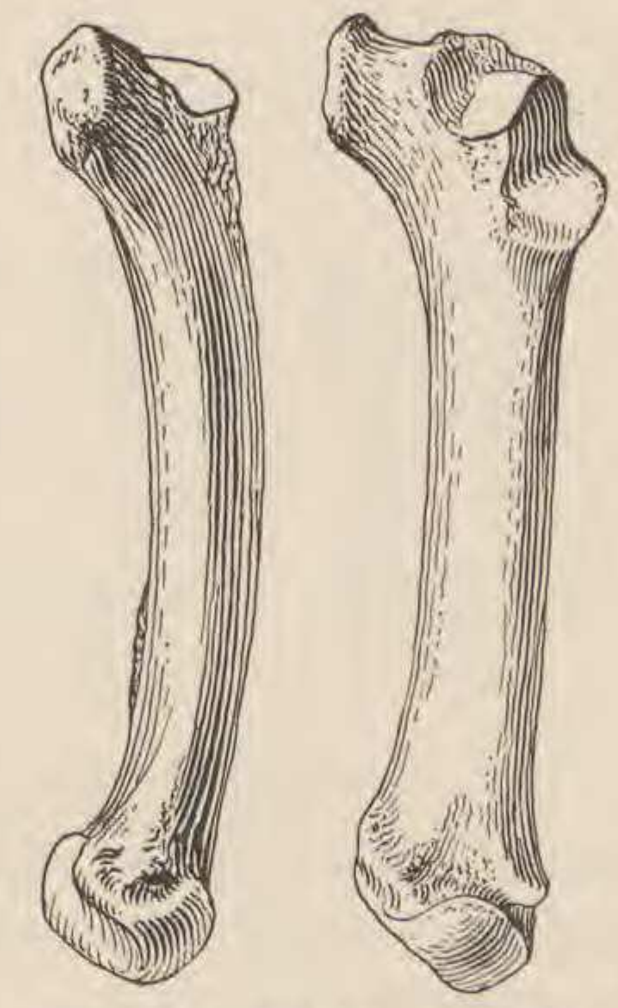

FIG. 54. Fibular and Dorsal Views of Right Metatarsal V of *D. superbus*. Nat. size.

Cynodesmus brachypus is an animal of considerably smaller size than *Daphœnodon*, but Mt. V, which is represented in the type, is of very nearly equal length, though much lighter than that of *Daphœnodon*. The ascending process on the fibular angle of the head is much larger than in *Canis*, but it is directed upward and outward pretty much as in the latter, and the articulation for the cuboid is small and faces directly upward as in the recent form, entirely unlike that of *Daphœnodon* and *Daphœnus*. Another modified character of importance in Mt. V of *C. brachypus* is seen in the shaft. The latter is more arched in the dorsal direction than in *Canis*, but it is plainly seen that the proximal half is trihedral, which is due to the more complete parallel arrangement of the metatarsals, approaching, condition found the in the modern *Canidæ*, while in *Daphœnodon* and its progenitors the upper portion of the shaft is transversely oval, due to a less appressed condition and a more direct divergence from the proximal ends, which is a general feature of the early types of the *Miacidæ*.

MEASUREMENTS OF METATARSAL V.

	Mm.
Greatest length	62
Antero-posterior diameter of head	13
Transverse diameter of head	19
Transverse diameter of distal end	12

Sesamoids. — The sesamoids are proportionally somewhat smaller than in the recent canids, but have otherwise no noteworthy features differing from the latter.

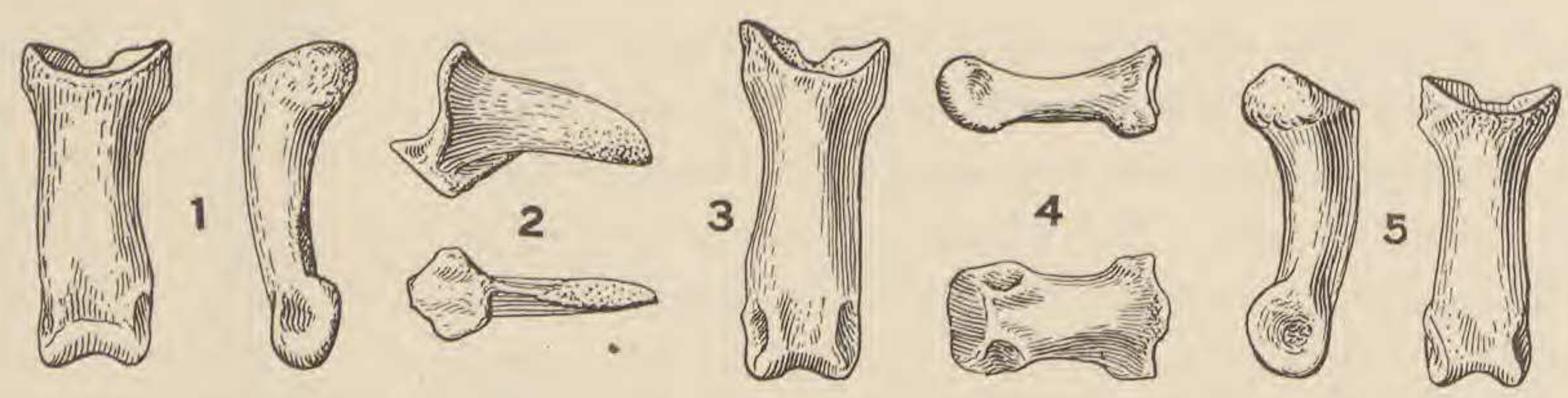

FIG. 55. Phalanges of Digits III, IV, and V, of Right Hind Foot of *D. superbus*. Nat. size. 1, dorsal and tibial views of first phalanx of third digit; 2, fibular and plantar views of terminal phalanx of third digit; 3, dorsal view of first phalanx of fourth digit; 4, tibial and dorsal views of second phalanx of fourth digit; 5, fibular and dorsal views of first phalanx of fifth digit.

Note: The hood of the ungual phalanx is partly broken off.

Phalanges. — The proximal row of phalanges are distinctly shorter in proportion to those in *Daphœnus*, which is also true of the phalanges of the manus. They are otherwise quite similar in structure, the proximal articulation being a concave pit with a broad plantar groove, and the distal trochlea confined principally to the plantar face. The median row of phalanges is asymmetrical in the same proportion as those in the manus, and indicate that the unguals were drawn toward the fibular borders when the little retractility which they undoubtedly possessed, was exercised. The unguals are similar to those in the manus.

MEASUREMENTS OF PHALANGES.

	Mm.
Greatest length of proximal phalanx, fourth digit	29
Greatest length of median phalanx, fourth digit	19
Greatest length of ungual phalanx, fourth digit	24

RESTORATION OF *Daphœnodon superbus*.

(Plates LXXXIII and LXXXIV.)

The unusually well preserved and symmetrical bones of the type of *Daphœnodon superbus* have caused comparatively little trouble in correctly articulating the different parts of the skeleton. The restoration has been very well executed by Mr. Serafino Agostini. The mounted skeleton furnishes many additional features of the animal which only in this way can be fully appreciated.

The position of the head is as high in relation to the horizontal line of the vertebral column as the animal ordinarily held it in life. The long neural spines on the cervical vertebræ further indicate that the animal probably carried the head rather low. The curvature of the neck at the junction of the thorax is gentle, and the position of each dorsal vertebra increases in height until the lumbar region is reached, where a sudden downward curvature again takes place, not unlike that in the recent tiger. The twelfth and thirteenth dorsals have no facets for a tuberculum of the ribs as in *Felis tigris* and it is quite doubtful whether the eleventh dorsal of the present form carried a tubercular facet for the rib as the transverse process is poorly developed. The thorax was on the whole quite small, which is also characteristic of the Oligocence genus. The heads of the ribs of the left side (except the eleventh or twelfth) are all represented, while the shafts are restored after the more completely preserved ribs of No. 1589a. On the left side the ribs are poorly preserved, there being present only the heads and portions of the shafts of seven.

The fore limbs display a close similarity to those in *Daphœnus*. The deltoid and supinator ridges of the humerus are prominent, the former low down on the shaft, indicating the downward extent of the heavy muscles, while the development of the latter indicates the power of supination of the manus. Though the forearm is proportionally longer than in the latter genus the feet are remarkably little advanced, being short and broad, the pollex little reduced, and the position of the phalanges sharply angled as in the felines, but proportionally somewhat shorter than in *Daphœnus*. The power of retractility of the unguals was nearly as great as in the older form and no doubt still served the purpose of assisting in catching and holding the prey.

As has already been stated the posterior portion of the pelvis, portions of the femora, and the proximal ends of the tibiæ were unfortunately weathered out and disintegrated when the specimen was found, but from other material the comparative measurements were made, and the proportions, as they are in the skeleton represented on Pls. LXXXIII-LXXXIV, are thought to be approximately correct. The hind feet are also quite broad, but somewhat longer than the fore feet, while the ungual phalanges of the former had apparently a power of retractility equal, or nearly equal, to that of the latter. Altogether the skeleton shows a long and comparatively slender body, long tail, and short and heavy limbs with broad and short feet.

MEASUREMENTS OF SKELETON.

	Cm.
Greatest length of vertebral column, the skull and all curvatures included	210
Length of vertebral column, atlas to posterior end of sacrum	92
Length of tail, approximately	88
Length of lumbar series	26.5
Length of dorsal series	33
Length of cervical series	21
Height of skeleton at first dorsal	57
Height of skeleton at first lumbar	61
Height of skeleton at supra-iliac border, approximately	58

NOTES ON INDIVIDUAL VARIATION OF *Daphœnodon*.

The superior dentition of the material at hand shows very little variation in general character, except in the young individual (No. 1589a) found with the type of *Daphœnodon superbus* and described on pages 210 and 215. The mandibular symphysis in some individuals however, is, longer, $p_{\overline{1}}$ has been dropped out and the alveole closed up, while $m_{\overline{3}}$ is sometimes inserted by two strong fangs.

In a series of cervicals (No. 1589b), the fourth, fifth, sixth, and seventh, which were found on the surface and in the talus at Quarry No. 3 (Agate Spring Fossil Quarries), are seen some differences from those described of the type of *Daphœnodon superbus*. These differences are most likely due to individual variation and sexual distinction, and will be thus treated in this connection pending the discovery of more material.

This cervical series is in the first place considerably heavier and pertains to a larger individual than the type specimen. Secondly, the ventral keels appear to terminate posteriorly in a more condensed rugose tubercle approaching more nearly that of *Canis* in its characters than to that of the type of *Daphœnodon*. Thirdly, the anterior projection of the transverse process of the sixth cervical vertebra in the series under consideration is much smaller than the corresponding portion in this vertebra of the type specimen. One of the more significant differences from the latter is seen in the sixth and seventh cervicals. The base of the neural spine of the seventh cervical is more nearly oval in cross-section, with no such excavations in front or back of the spine as is characteristic of the type specimen described above. The base of the spine of the sixth cervical is also without these excavations, so that it is quite safe to say that this individual did not possess this character of the vertebræ. Another important feature is seen in the prominent antero-posterior ridge in the floor of the neural canal, which is pierced by a transverse venous foramen, while in the type specimen this ridge is rather poorly developed and the area in the middle region, where the foramen is located in the larger specimen, is much greater and was not always bounded above by a bony bridge so as to form a foramen. The transverse process is proportionally much shorter, which would indicate a narrower neck in the larger individual.

In the Amherst specimen, which is about equal in size to the one represented by the cervical vertebræ described above, there are some lumbar vertebræ preserved. One of these has the transverse processes preserved. These processes are proportionally longer than those in the corresponding region of the lumbars in the type, and more in accordance with the conditions found in *Daphœnus*, *Temnocyon*, and the recent forms. The os penis of the Amherst specimen of *Daphœnodon* is greatly different from that in No. 1589a (Carn. Mus. Cat. Vert. Foss.) and is described on pages 230 and 231.

Relationships of *Daphœnodon*.

That *Daphœnodon* had its true ancestor in *Daphœnus* of the Oligocene formation can hardly be doubted, from the study which has resulted in the above comparative description. *Daphœnus* in turn is generally regarded as a descendant of the *Miacidæ* of the earlier Tertiary of North America. In the Oligocene and early Miocene there were a number of diverging lines, which as a whole were nevertheless quite homogeneous in their general structure, though apparently sufficiently diversified to show with more or less clearness their destiny in later times. These points have already been ably treated by Scott, Boule, Schlosser, Matthew, Merriam, Hatcher, Wortman, and others, and will not be discussed in the present paper, except in so far as to assign the phyletic position of *Daphœnodon*.

It would appear that *Daphœnodon* is not yet represented by any very closely allied species[20] in the intervening formations from the lower Harrison beds down to the lower portion of the Oligocene where *Daphœnus*, its predecessor, is found. The genera from the John Day are already too far advanced in different ways to be seriously considered as intermediate forms. Thus *Temnocyon* and *Mesocyon* have $m^{\underline{3}}$ absent and differ in many other important respects, some species[21] of the latter genus having a well developed entoconid on the lower sectorial, and being possibly

[20] *Mesocyon robustus* Matthew from the lower Miocene of South Dakota bears general similarities, but m_2 is apparently too much reduced and more trenchant, and m_3 is probably sometimes absent.

[21] *Mesocyon Josephi* (?). See Merriam, Univ. of Cal. Publications, Bull. Dept. Geol., Vol. V, pp. 19-20, 1906.

more nearly in the ancestral line of *Cynodesmus* (*C. brachypus*). *Philotrox*, *Hyænocyon*, and *Enhydrocyon* are removed from this line by the reduction of the premolars and other important features. *Paradaphœnus* is a small form with long narrow skull, deuterocone of p^{4} well internally, M^{3} aligned with the outer cusps of the anterior molars, heel of lower molars basin-shaped, and tympanic bulla of proportionally larger development.

Of the later American forms which are perhaps most closely related to *Daphœnodon*, *Amphicyon americanus* Wortman is quite well preserved and furnishes the most satisfactory comparison. This species, like the European, *A. major*, has the canines enormously developed and the premolars reduced when compared with *Daphœnodon*. P_{4} is less oblique in the alveolar border, M^{1} and M^{2} are apparently more nearly subequal in size, while M^{3} is aligned with the outside of the molars and is somewhat larger than in the latter genus. *Amphicyon major* of Europe is further differentiated from the present form by its short, broad, bear-like astragalus and sub-plantigrade hind feet.

Amphicyon lemanensis is another well known European form bearing certain resemblances to *Daphœnodon superbus*, but which on closer study displays numerous differences, among which mention may be made of a larger size three-rooted and tri-cuspid M^{3}, a smaller P^{4}, proportionally longer, narrower, and higher skull, as well as a differently constructed axis, and other characters of importance.

Amphicyon crucians, figured by Dr. Filhol (Ann. des Sciences Géologique, Vol. X, pl. 12, figs. 1–3, 1879) show only general similarity to *Daphœnodon*, so far as comparison can be made, the crowns of the premolars being higher and more pointed, and P_{3} having a basal tubercle, while that tooth in *Daphœnodon* has none.

Cephalogale geoffroyi is, with regards to the general features of the skull, more like *Daphœnodon*, but the proportions and construction of the tubercular molars are different, M^{3} being absent, and this European form is apparently no nearer related to *Daphœnodon* than for instance the American genus *Ælurodon*. In fact the apparent relations observed between the European and American forms here compared should perhaps be regarded as purely superficial and due entirely to independent development without necessarily close relationship.

With regard to the ancestry of the genus described above there can certainly be no doubt that we find in *Daphœnus* from the American Oligocene all the required characteristics pointing more clearly to *Daphœnodon* than they are so far found in any known European forms, the ancestral types of the latter genera having perhaps already occupied contemporaneously these European regions for a long time.

From the study of the osteology of *Daphœnodon superbus* it is quite evident that this genus belongs to a phylum existing through the Oligocene and Miocene periods, with rather conservative adaptations when compared with such forms as *Temnocyon*, *Mesocyon*, *Cynodesmus*, *Tephrocyon* and in fact with many coexisting forms of *Canidæ*. Although the genus should be, for the present at least, regarded as belonging to the subfamily *Amphicyoninæ*, it is not altogether unlikely that, upon gaining more complete knowledge of all the different supposed allied forms, it will be regarded as representing a separate subfamily (*Daphœninæ*) paralleling *Temnocyon*, *Mesocyon*, *Cynadesmus*, and *Tephrocyon* on the one hand and the true *Amphicyon* on the other, but less differentiated from *Daphœnus* than either of the genera regarded as descendants from the Oligocene forms. The phylum terminated, most probably, in some such forms as *Dinocyon* or *Borophagus*, or perhaps in some of the so-called *Amphicyones* in later formations of North America, while the *Amphicyoninæ* of Europe were paralleling the line.

This would seem to lend color to Mr. Hatcher's contention [22] that *Protemnocyon* and *Proamphicyon* are both valid genera, the former pointing to *Temnocyon* and *Mesocyon*, while the descendants of the latter, if not "*Amphicyon*" as Hatcher believed, may not yet have been discovered. The reduction or apparent absence of $M\frac{3}{}$, together with other features in *Protemnocyon* from the Oligocene, is suggestive of the later John Day form, while $M\frac{3}{}$ in true *Daphœnus* still persists in an almost unchanged form in *Daphœnodon* from the Miocene.

The bony structure of *Daphœnodon*, though extremely cat-like in many respects, is on the whole more closely related to the *Canidæ*, of which family it was an aberrant line not continued to the present time. A fairly good attempt has been made by Mr. Theodore A. Mills to construct the soft parts of *Daphœnus felinus*, from the skeleton which is now in the Carnegie Museum. And the curious combination of the characters of the cat and the dog are, if anything, even more striking when an allowance of flesh is represented upon the bony structure (see Pl. LXXXV). The downward extent of the heavy muscles of the limbs, the broad and short feet, with the semi-retractile claws, the long body and tail are especially cat-like, while the head is dog-like in every respect. The tail is represented more or less like that of *Felis concolor*, there being no perceptible means of knowing whether this appendage was bushy, as in the dogs, or more slender as in cats generally. Altogether the model represented by the figure on Pl. LXXXV is instructive, as it furnishes at least a conception of a primitive form ancestral to cats and dogs. Of this primitive stem *Daphœnus* and especially *Daphœnodon* on the whole, appear to be far less specialized

[22] "Oligocene Canidæ," *l. c.*, p. 105.

than most of their contemporaneous forms and consequently more nearly like the old types of the Miacidæ from the Eocene formations.

Canid (Undetermined Species).

A humerus (No. 2400) of a very large canid, the size of a lion, was found in the lower Harrison beds on Whistle Creek, Sioux County, Nebraska, about eight or ten

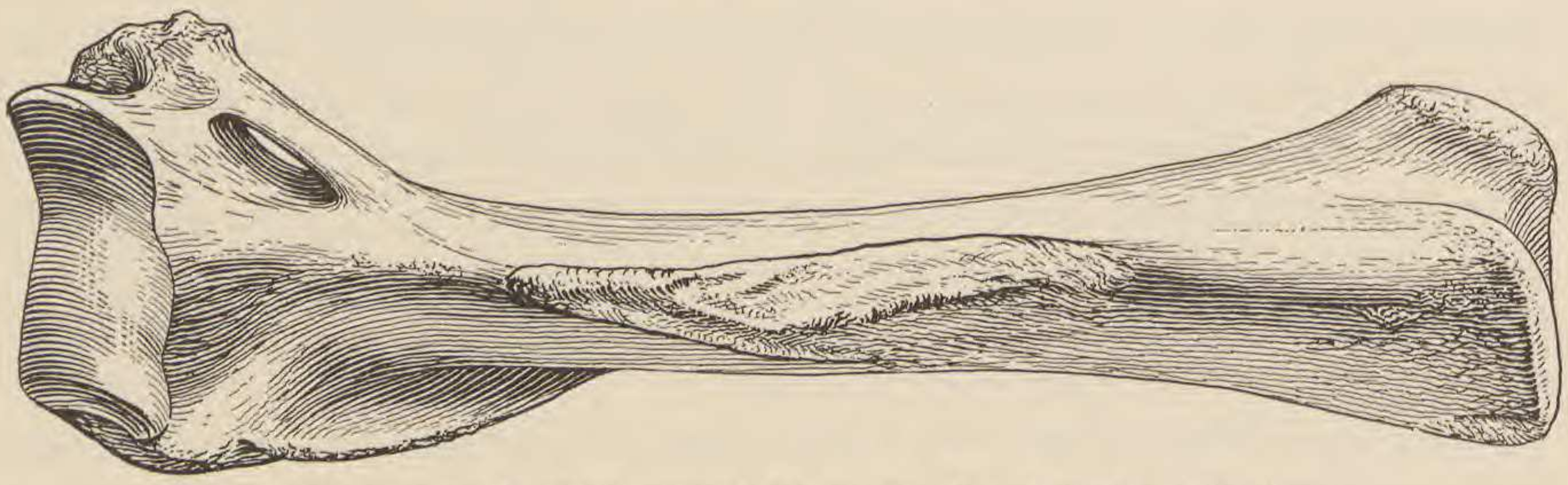

FIG. 56. Anterior View of Humerus of Canid. Sp. indt. ½ nat. size. No. 2400.

miles east of the Agate Spring Fossil Quarries. With the exception of its greater size and the greater distal extent of the deltoid ridge this humerus most nearly resembles that of *Daphœnodon.* The bone is very nearly the size of the humerus of *Amphicyon major* of Europe and not unlike the latter, so far as comparisons can be made. In the American species, however, the deltoid ridge extends lower down and the anconeal fossa is not so high as in the European species. The humerus possibly represents some genus closely related to such large forms as *Dinocyon* from the later Tertiary of Montana described by Mr. E. Douglass[23] or *D.* (*Borophagus*) *gidleyi* from the Miocene of Texas described by Dr. W. D. Matthew.[24] The quarry in which the humerus (fig. 56) was found contains a similar fauna to that of the Agate Spring Fossil Quarries.

FIG. 57. Fibular and Anterior Views of Calcaneum of Canid sp. indet. ½ nat. size. No. 2211.

A fifth metacarpal (No. 1897) of a large carnivore, which may belong to this species, was found by the writer in 1904 among the surface fragments in the quarry, which was worked the following years by Professor Barbour (Agate Spring Fossil

[23] "New Vertebrates from the Montana Tertiary," Ann. Car. Mus., Vol. II, p. 192, 1903.

[24] "A Skull of Dinocyon from the Miocene of Texas," Bull. Amer. Mus., Vol. XVI, p. 129, 1902.

Quarries, "University Hill" Quarry). This bone is very heavy, short, and much arched in the dorsal direction. A calcaneum of nearly an equally large carnivore was found in the same horizon north of the Niobrara River in this general locality and is illustrated on page 262, Fig. 57. The remains indicate the presence of these large carnivores in the fauna found in these quarries.

MEASUREMENTS.

	Mm.
Greatest length of humerus	305
Greatest antero-posterior diameter of head	87
Greatest transverse diameter of head	68
Greatest length of Mc. V	63
Greatest length of calcaneum	90
Greatest transverse diameter at sustentacular facet	45

Borocyon* robustum gen. et sp. nov.

Type: (No. 1918, Carn. Mus. Cat. Vert. Foss.) Front of right ramus, caudal vertebræ, fragments of manus, part of hind limb and foot, and various other fragments.

Horizon: Miocene, Upper Harrison beds.

Locality: Whistle Creek, Sioux County, Nebraska.

Mr. T. F. Olcott, while engaged with the Carnegie Museum party in 1905, discovered and collected this specimen about four or five miles southeast of the Agate Spring Fossil Quarries. As indicated above it was found in the upper Harrison beds. Although the type is fragmentary it enables me to give some characters which may be regarded as of generic value. The type is perhaps more closely allied to such forms as *Amphicyon sinapius* Matthew from later horizons than to *A. americanus*, *A. ursinus*, or any of the European forms with which it has been compared. The jaw is undoubtedly quite short and heavy, and the premolars are of considerable size when compared with *A. ursinus*. The portion of the jaw preserved compares fairly well with *Ælurodon taxoides* Hatcher, but the canine is heavier and $P_{\overline{2}}$ has no posterior cusp as in that species. *A. meandrinus* had the jaw proportionally longer in front of $P_{\overline{1}}$ than the present genus. It is, of course, quite provisionally that this genus is placed in the *Daphænus-Daphænodon* phylum, but pending the discovery of more complete material it would seem most satisfactory from the study of the limb and foot structure to regard the genus as a later member of this aberrant line. The material represents an animal nearly the size of a fully adult lion.

Generic characters. Canine proportionally large and oval in cross-section, $P_{\overline{1}}$ single-rooted, $P_{\overline{2}}$ low-crowned with protoconid well anteriorly, no posteriar cusp, and a large

* βορός = greedy; κύων = dog.

posterior base, $M_{\overline{3}}$? present, heavy and elongated tail, limbs and feet well proportioned and sub-digitigrade as in Daphœnus and Daphœnodon, little or no retractility of the unguals.

GENERAL DESCRIPTION AND SPECIFIC CHARACTERS.

The material represents a fully adult animal judging from the much worn canine. The latter is oval in cross-section and is proportionally larger than that tooth in *Daphœnodon.* Judging from the abraded anterior face of the canine it is quite evident that $I^{\underline{3}}$ was of large size as in *Daphœnodon.* The postero-external angle of the canine is also worn by the contact with the upper canine. As in

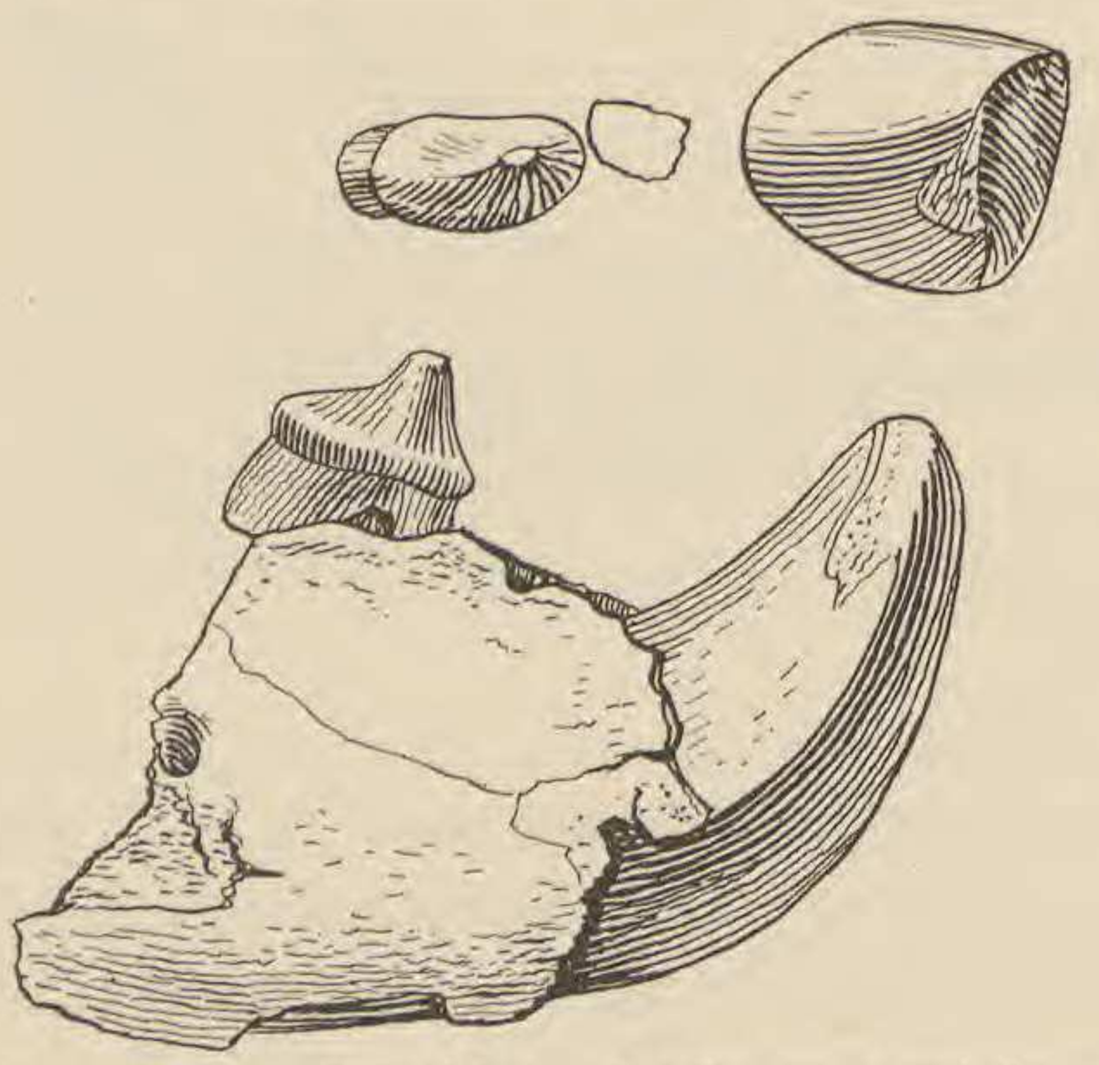

FIG. 58. Right Side of Lower Jaw-fragment and Crown View of Teeth of *Borocyon robustum.* Nat. size. No. 1918.

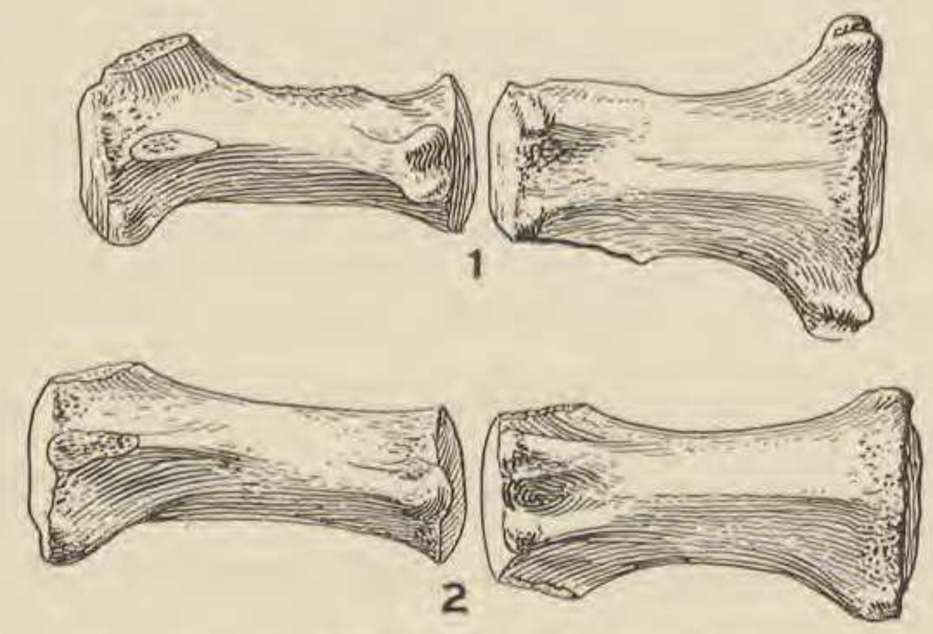

FIG. 59. Caudal Vertebræ of *Borocyon robustum.* ½ nat.? size. No. 1918. 1, lateral and ventral views of caudal 7; 2, lateral and ventral views of caudal? 9.

Daphœnodon there is a short diastema back of the canine. $P_{\overline{1}}$ is single-rooted. $P_{\overline{2}}$ is low-crowned and has the protoconid placed more anteriorly than in *Daphœnodon,* which results in a less developed anterior and greater posterior base than on $P_{\overline{2}}$ in the latter genus. There is no posterior tubercle on $P_{\overline{2}}$ as in *Ælurodon,* but the cingulum is well developed; it surrounds the tooth and is smooth on the external side, while internally it is slightly mammilated. There is a large mental foramen directly under the posterior portion of $P_{\overline{2}}$. The symphysis is quite heavy and extends well back as in *Daphœnodon.*

The only parts present representing the vertebral column in the type are a number of caudal vertebræ from different regions of the tail. The centra of these vertebræ are long and heavy, indicating a tail of approximately the same proportions as that of *Daphœnodon.*

The manus is represented by a complete trapezoid, Mc. I, and other fragments. The trapezoid is depressed and wide transversely, indicating a broad manus. The facet for the scapho-lunar is slightly convex from before backward near the dorso-radial angle, while further back and along the ulnar portion it is concave in the same direction. Radially there is a large facet for the trapezium, which takes up nearly the entire face. On the ulnar side the facet, for the lunar, meets that for the magnum at an acute angle so as to form a prominent ridge, which extends a short distance back from the dorsal border. Back of the ridge the ulnar face is taken up by a large rugose area for the attachment of muscles and ligaments. On the distal face there is a large subtriangular articulation for the second metacarpal.

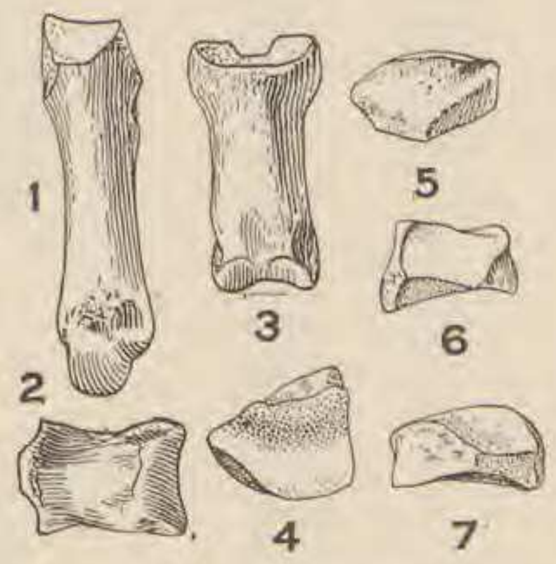

FIG. 60. Foot Bones of *Borocyon robustum.* ½ nat. size. No. 1918. 1, dorsal view of metacarpal I; 2, dorsal view of a second phalanx; 3, dorsal view of a first phalanx; 4, proximal view of trapezoid; 5, dorsal view of trapezoid; 6, radial view of trapezoid; 7, ulnar view of trapezoid.

The free end of the pisiform indicates this bone to be quite like that in *Daphœnodon.*

Mc. I has the head less expanded transversely, the shaft less arched forward, and less curved outward at the distal end than that of *Daphœnodon superbus;* there is otherwise little or no difference between this bone in the two forms. Other fragments of the metacarpals suggest heavy bones in this region.

The phalanges are proportionally short when compared with *Daphœnodon.* Those of the proximal row are otherwise arched in the dorsal direction similar to the conditions found in the latter genus, while the median phalanx is depressed and broad. There is no ungual phalanx present with the type.

The hind limb is represented by the lower half of the tibia and fibula, the astragalus, navicular, ento-, meso-, and ectocuneiforms, and other fragments.

With the exception of the proportionately somewhat greater antero-posterior diameter of the distal end, the tibia offers little or no characteristic differences by which it may be distinguished from that of the smaller genus. The distal end of the fibula is more compressed laterally than in *Daphœnodon;* otherwise there is also little difference in this bone in the two forms.

The astragalus has a slightly longer neck and the articular surface of the trochlea descends lower than in *Daphœnodon,* otherwise this bone does not differ in the two genera. The principal difference of the navicular from that of *Daphœnodon* is seen in the smaller development of the plantar tuberosity; the rugose area for muscular attachment slanting more upward and backward, resulting in the comparatively small vertical diameter of the tuberosity. The entocuneiform is quite large, and of good proportionate vertical diameter. The tibial plantar angle is more concave in the vertical direction than in *Daphœnodon*, which results from the greater development of the ascending plantar tuberosity of the present form. The meso- and ectocuneiforms are similar to those in *Daphœnodon*.

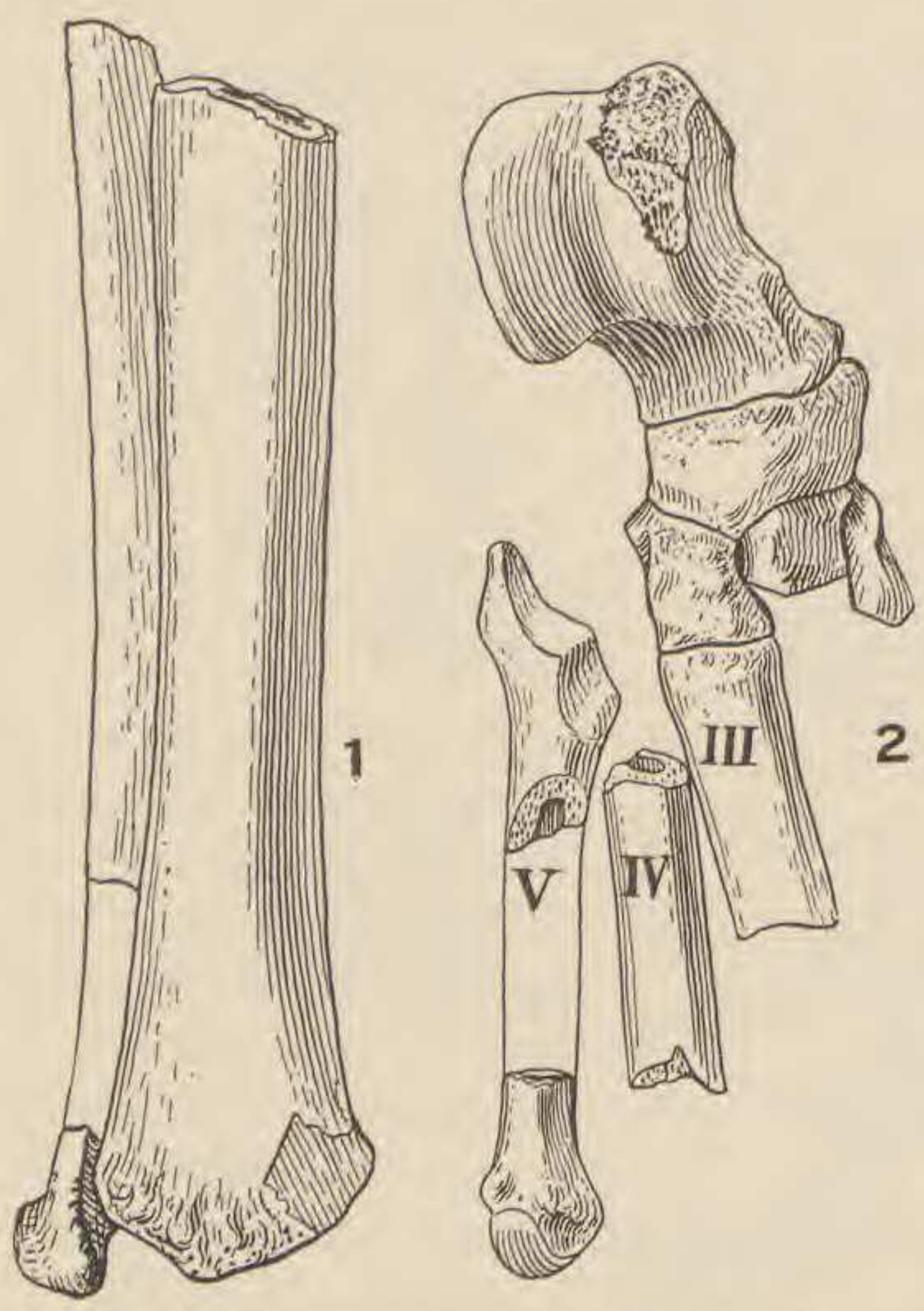

FIG. 61. Fragments of Hind Limb and Foot of *Borocyon robustum*. ½ nat. size. No. 1918. 1 dorsal view of tibia and fibula; 2, dorsal view of hind foot.

Metatarsal III has the articular surface for the ectocuneiform less oblique and the tibial and fibular faces of the head less excavated than in *Daphœnodon*. Mt. V is quite unlike that of the latter genus in respect to the articular facets of its head. The tibial face has a somewhat smaller facet for Mt. IV and the facet for the cuboid is entirely proximal, while in *Daphœnus* and *Daphœnodon* the facet for the cuboid extends well in the fibular direction, encroaching on the base of the ascending process so as to form a lateral as well as a proximal contact with the cuboid. Another important difference from the older forms is seen in the vertical position of the ascending process on the fibular face of the head. In the Oligocene and Miocene forms, here used for comparison, this process is very heavy and projects upward and outward forming, with the excavation for the peroneus longus tendon on the cuboid, a transversely broad groove. In the present genus the ascending process, though large, is directed more vertically and the space between it and the fibular face of the cuboid is comparatively narrow. Near the proximal ends the shafts of the meatarsals are slightly triangular in cross-section. The distal end of Mt. V? is somewhat less expanded transversely than in *Daphœnodon*, but the trochlea is quite similar, being very convex dorsally and separated by a prominent carina on the plantar aspect.

MEASUREMENTS.

	Mm.
Antero-posterior diameter of canine at base	21
Transverse diameter of canine at base	15
Antero-posterior diameter of p_2	14
Transverse diameter of p_2	18
Vertical diameter of ramus at p_2	35
Length of ? ninth caudal	58
Antero-posterior diameter of trapezoid	19
Greatest transverse diameter of trapezoid	20

Greatest vertical diameter of trapezoid	12
Length of Mc. I	49
Greatest transverse diameter of head Mc. I	12
Greatest length of proximal phalanx of 3rd or 4th digit	31
Greatest length of median phalanx of 3rd or 4th digit	21
Height of tarsus	86
Transverse diameter of tarsus, approximately	58
Height of astragalus	50
Greatest transverse diameter of astragalus	40
Greatest transverse diameter of trochlea of astragalus	28
Antero-posterior diameter of navicular	30
Greatest transverse diameter of navicular	36
Greatest vertical diameter of navicular	18
Antero-posterior diameter of entocuneiform	17
Transverse diameter of entocuneiform, distal end	7
Vertical diameter of entocuneiform	25

Cynodesmus thomsoni Matthew.

Bull. Amer. Mus. Nat. Hist., Vol. XXIII, p. 186, 1907.

This species is represented by a considerable portion of a skeleton (No. 1529, Carn. Mus. Cat. Vert. Foss.) found in the upper Harrison beds on the Niobrara River, Sioux Co., Nebraska, and adds to our knowledge of that species. According to Dr. Matthew's statements there are apparently no hind feet with the type, while in the present specimen both fore and hind feet are quite well preserved and indicate about the same proportionate size as those of *Cynodesmus brachypus*. In fact most of the skeletal features are quite similar to those of the latter species so far as they can be compared. $P^{\underline{4}}$ is absent on both sides and considerable crushing has taken place at the base of the skull of *C. brachypus* which prevents a very accurate comparison, but it is quite evident that $M^{\underline{2}}$ is fully as much reduced comparatively as in *C. thoöides* Scott, and is considerably smaller than in the type of *C. thomsoni* and the specimen in our collection referred to the latter species. These and other differences of the dentition no doubt indicate more progressive development in *C. brachypus* and *C. thoöides* so far as certain features of the dental structure are concerned. The structure of the feet and limbs certainly approaches very much nearer the conditions found in *Canis* than is the case in *Daphœnodon*. Among these may be mentioned the higher position of the deltoid crest, the less prominent supinator ridge of the humerus, the reduced distal end of the ulna, the laterally expanded supra-iliac border the concave gluteal surface and shorter ischium of the pelvis, the more completely grooved astragalus, the proportionally greater length of the metatarsals over the metacarpals, the tendency of the metatarsals to become appressed at their proximal ends, and the more reduced pollex and hallux.

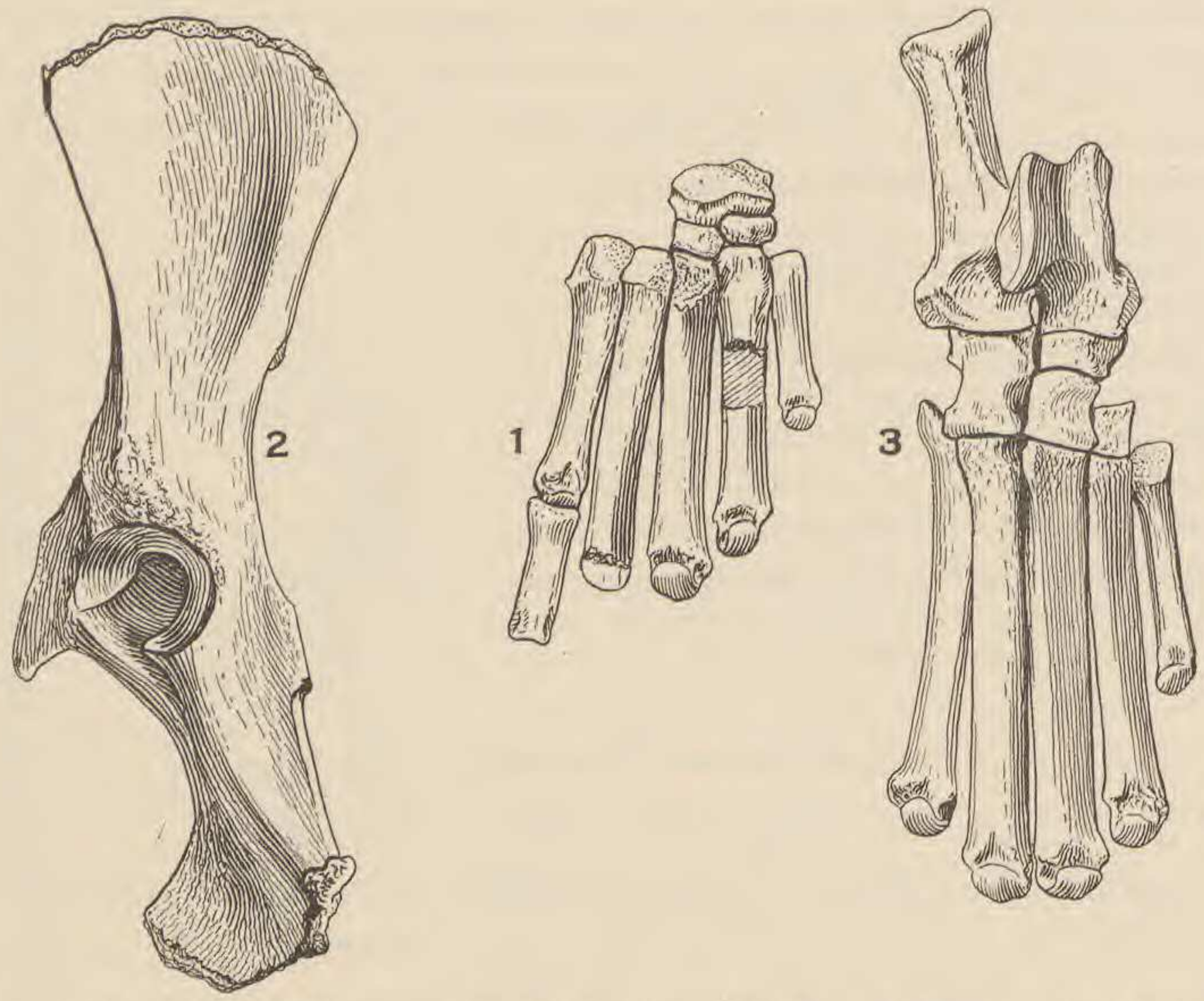

FIG. 62. Pelvis and Feet of *Cynodesmus thomsoni* Matthew. Nat. size. No. 1591. 1, anterior view of manus; 2, external view of pelvis; 3, anterior view of pes.

When the skull of the present specimen (No. 1591) is compared with Matthew's description and figures (*l. c.*, pp. 186–188) it is seen that in practically all the details of structure, except the apparently smaller brains in our specimen, which may be due to crushing, the two specimens agree quite closely. $P_{\overline{2}}$ in the Carnegie Museum specimen has no posterior cusp, while Dr. Matthew's figure indicates one on the type. The present specimen represents an old individual, as the tubercular teeth are much worn.

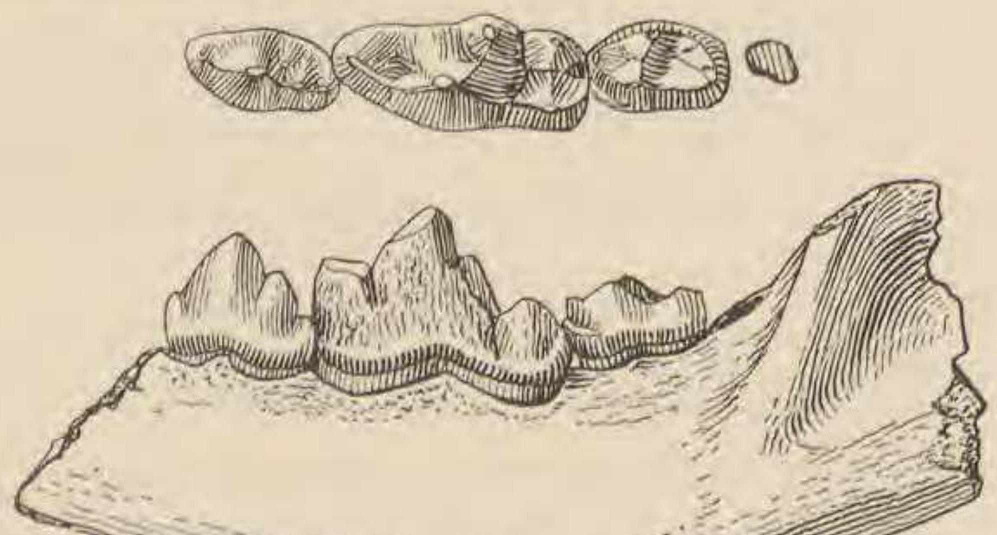

FIG. 63. Crown View of Teeth and External View of Jaw-fragment of *Tephrocyon* (Canis) *temerarius* Leidy. Nat. size.

Tephrocyon (Canis) temerarius Leidy.

Proc. Acad. Nat. Sci. Phila., p. 21, 1858; Jour. Acad. Nat. Sci., Vol. VII, p. 29, Pl. I, fig. 12, 1869.

A fragment of a lower jaw (No. 2404, Carn. Mus. Cat. Vert. Foss.) is provisionally referred to this species as the measurements and general appearances are quite close to those of the type. The present specimen was found on Whistle Creek, Sioux

County, Nebraska; it was lying on the surface and possibly pertains to a later Miocene or Pliocene deposit which apparently thinly covers the lower Miocene section in certain places in this valley. The accompanying figures are given in order to show the close similarity of this species to *T. rurestris* Merriam and *T. hippophagus* Matthew and Cook.[24] The only differences between the present form and *T. hippophagus* so far as comparison can be made, is the smaller size and the slightly slenderer jaw of *T. temerarius.*

MUSTELIDÆ.

Paroligobunis (Brachypsalis) simplicidens *gen. nov.*

Annals Carnegie Museum Vol. IV, pp. 44–46, 1906.

Type: Right mandibular ramus (No. 1553, Carn. Mus. Cat. Vert. Foss.).

Horizon: Lower Harrison beds (Miocene).

Locality: Near Agate Spring Fossil Quarries, Sioux County, Nebraska.

Plesiotype: Left mandibular ramus, greater portion of femur, fibula, and bones of fore and hind foot (No. 2389, Carn. Mus. Cat. Vert. Foss.).

Horizon: Lower Harrison beds (Miocene).

Locality: Agate Spring Fossil Quarries (quarry No. 3), Sioux County, Nebraska.

Generic Characters. — Dentition, $\frac{}{?3.1.4.2.}$. *Canine heavy and oblong in cross-section. Premolars crowded, heavy, rather bluntly crowned, no accessory posterior cusps except on* $p_{\overline{4}}$. *Carnassial comparatively large, approaching condition in recent forms (Gulo), but possesses a small entoconid which is located high up on the crown.* $M_{\overline{2}}$ *much reduced in size. Femur longer than the tibia in the same proportion to that in Meles or Gulo. Feet broad and short; pes sub-plantigrade; unguals not retractile.*

GENERAL DESCRIPTION OF THE PLESIOTYPE AND SPECIFIC CHARACTERS.

The lower jaw is only very slightly larger than that in the type of this species previously described and is much larger than *Meles taxus.* The mandible below $p_{\overline{3}}$ is very deep and the posterior mental foramen is located directly below the posterior fang of p_3. Judging from the bottom of the alveolus for the canine, that tooth was strongly developed and the premolars appear to have been crowded, as in the type.

The inferior border of the horizontal ramus is gently convex in the fore-and-aft direction, as in the type. Opposite the vertical ramus the inferior border is only slightly raised as in *Gulo luscus* and unlike that in *Meles,* in which the angle is higher. The posterior portion of the lower jaw as a whole is otherwise very like that of the latter genera; possessing a large and deep temporal fossa, a large

[24] Matthew, W. D., and Cook, Harold J., Bull. Amer. Mus. Nat. Hist., Vol. XXVI, p. 373, 1909.

coronoid process, transversely broad and well rounded condyle, heavy masseter ridge, and prominent hook-like angle. The condyle is on a horizontal line with the dentition and is slightly lower than in *Meles taxus* and more like that of *Gulo luscus*. The ramus is broken in the region of $p_{\overline{1}}$ but this tooth is present in the type. $P_{\overline{2}}$ is

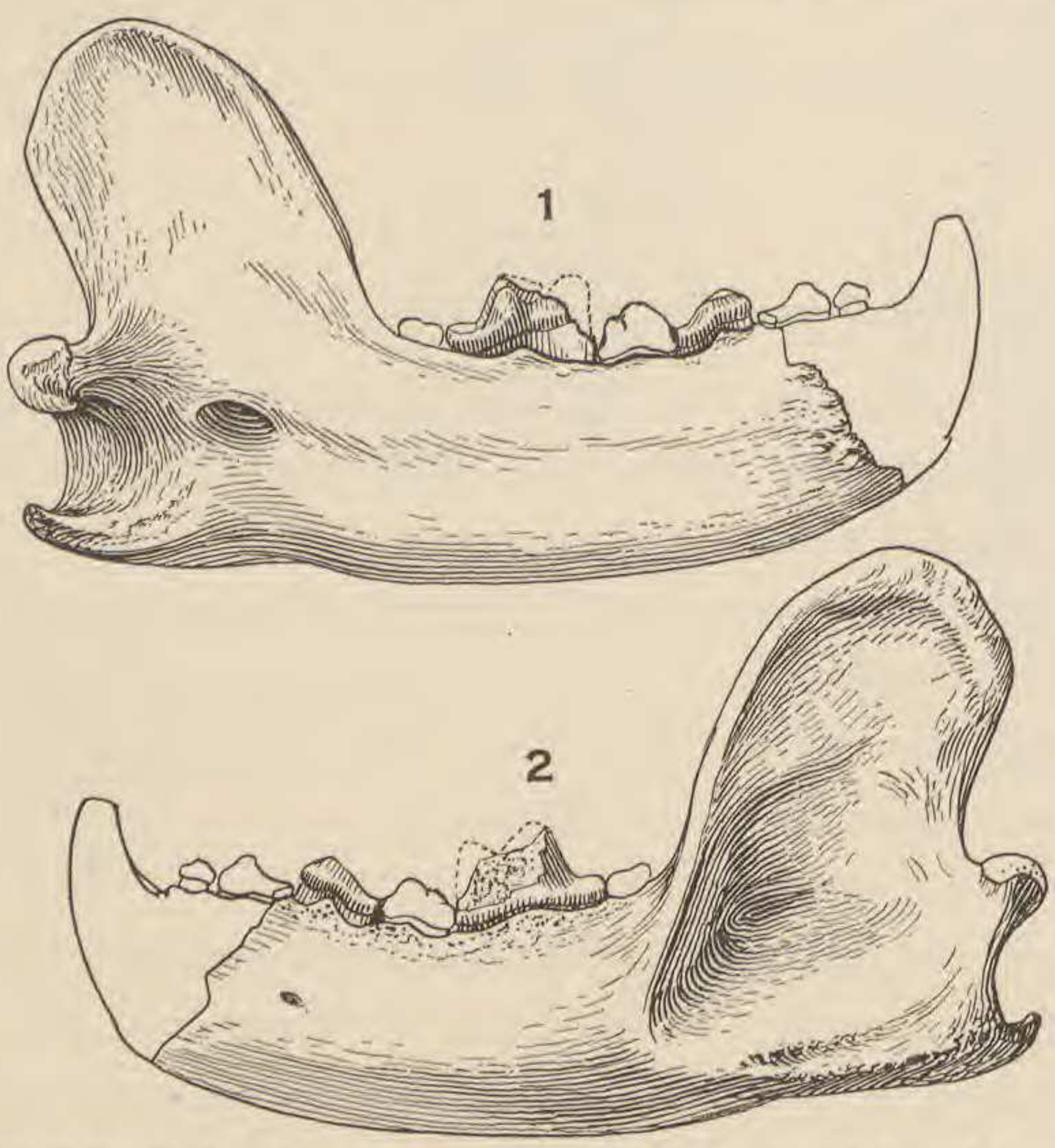

FIG. 64. Lower Jaw of *Paroligobunis simplicidens*. $\frac{2}{3}$ nat. size. 1, internal view of jaw ; 2, external view of jaw.

of considerably large size judging from the posterior root, which is still in position in the jaw. $P_{\overline{3}}$ is robust, and, as in the type, has a great transverse diameter with the protoconid placed well anteriorly. Internally there is a smoothly rounded cingulum, which continues from the antero-internal angle of the tooth, as in *Gulo luscus*, and is somewhat more developed than in the type. The crown of the tooth is much abraded showing that the animal was fully adult. Back of $p_{\overline{3}}$ is a space of 11 mm. for $p_{\overline{4}}$. $M_{\overline{1}}$ is unfortunately broken anteriorly so that the blade cannot be described. The metaconid is preserved and is rather small and placed high up on the crown. The heel is of moderately large size with the hypoconid well developed, forming the external edge of the heel, while the entoconid is probably absent.[26] Back of $m_{\overline{1}}$ there is a small alveolus, indicating a single-rooted tooth, which was even smaller than that tooth in the type. The contour of the lower jaw and especially the dentition are on the whole rather more suggestive of *Gulo luscus* than *Meles taxus*.

[26] The abraded condition of the tooth does not admit of a positive statement as to the presence or absence of an entoconid.

MEASUREMENTS OF MANDIBLE.

	Mm.
Total length of the ramus fragment	110
Antero-posterior diameter of $P_{\overline{3}}$	11
Greatest transverse diameter of $P_{\overline{3}}$	8
Antero-posterior diameter of $M_{\overline{1}}$ approximately	18
Greatest transverse diameter of heel	8

Manus. — The manus is represented by a number of metacarpals of both sides, the unciform and trapezoid of the right foot and a phalanx; the latter may equally well belong to the hind foot.

The unciform is of very nearly the same proportionate height, but of less transverse diameter than in *Meles taxus;* the facet for the cuneiform descends on the ulnar side to about the same extent as in the recent form, while the facet for the scapho-

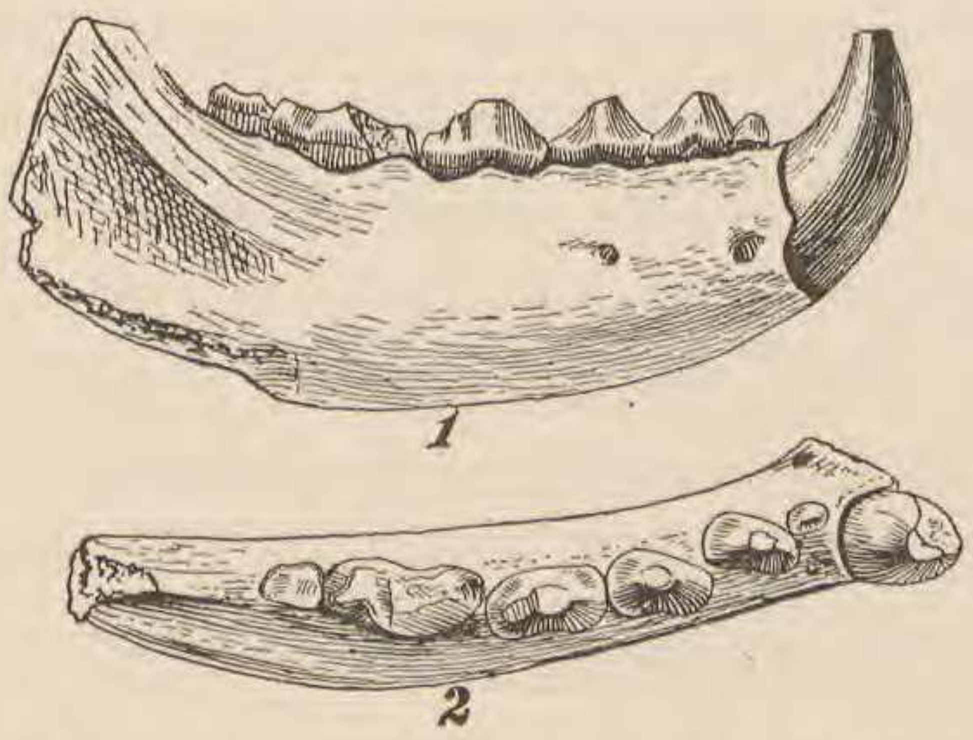

FIG. 65. Right Mandibular Ramus of *Paroligobunis simplicidens.* ⅔ nat. size. Type No. 1553. 1, external view; 2, crown view of teeth.

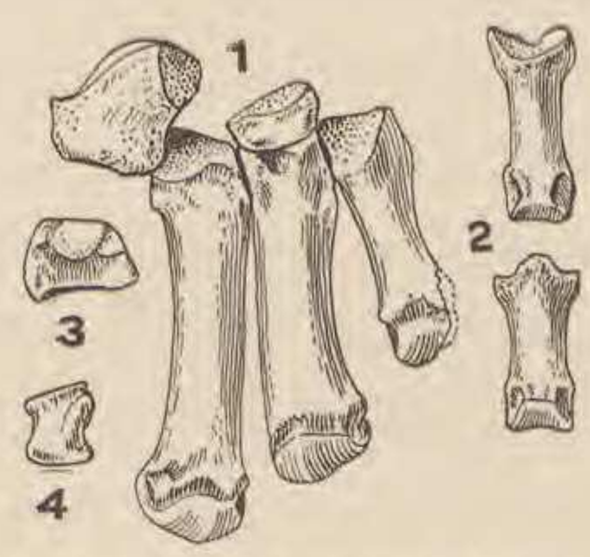

FIG. 66. Foot Bones of *Paroligobunis simplicidens.* ⅔ nat. size. No. 2398. 1, dorsal view of portion of right manus; 2, dorsal view of a first and second phalanx; 3, tibial view of mesocuneiform; 4, dorsal view of mesocuneiform.

lunar occupies a liberal portion of the radial angle. The facet for the magnum is continuous from the distal to the proximal face, as in *Daphœnus* and *Daphœnodon,* but the lunar facet is more distinctly separated from the facet for the magnum than in the latter genera. This is due to a prominent sinuous ridge, which extends from the dorsal border, obliquely upward and backward so that the upper portion of the facet for the magnum is concave supero-inferiorly, while the lower portion is plane antero-posteriorly; the facet for Mc. III near the distal face is convex antero-posteriorly. The palmar tuberosity is compressed transversely; it is more prominent than in *Meles taxus* or the recent otter, but does not extend so high up upon the palmar face as in *Daphœnus* or *Daphœnodon.* Distally the bone is much expanded and the articulations for Mc. IV and V are transversely broad and concave in the antero-posterior direction.

The trapezoid is quite depressed and triangular in outline. Its proximal face slants excessively downward in the ulnar direction, meeting the facet for Mc. II at an acute angle, so as to form a prominent and sharp ridge, which extends a short distance from the dorsal face backward almost identical with that in *Meles* and *Lutra*. Back of this ridge on the ulnar face is a rugose area for muscular attachments, the bone terminating palmarly in a round obtuse point. Distally the surface for Mc. II is convex transversely, the radial side less strongly than the ulnar, while antero-posteriorly the articulation is very slightly concave. The radial face is taken up almost entirely by the large facet for the trapezium. The latter is undoubtedly of large size judging from the large facets on the trapezoid and on Mc. I.

The first metacarpal is rather short when compared with that of *Gulo*, or even with that of the recent badger, and is more like that in the otter; it is also proportionally shorter than that in *Megalictis ferox* Matthew from the lower Miocene of South Dakota. The proportionate length of the metacarpals as a whole agree quite closely, however, with those in the latter genus. The facet for the trapezium is, as stated, of large size, and it is obliquely convex antero-posteriorly, extending well down on the shaft as in *Meles*, and is not unlike that of *Megalictis ferox* Matthew and *Æluro-cyon brevifacies* Peterson.[27] The shaft has received some injury in the process of collecting, but enough is preserved to show that it was heavy, well arched forward, and quite cylindrical. The distal trochlea is fully developed and carried the usual two phalanges.

The second metacarpal is quite heavy and in its general proportion it compares well with that in *Megalictis*. The head rises above that on Mc. III, so that the ulnar face has a facet for the magnum similar to that in *Meles*, while in *Megalictis* the head is apparently raised higher (see illustration, fig. 15, of Dr. Matthew's paper, *l. c.*). The facet for the trapezoid is concave transversely, the ulnar angle being higher than the radial. The palmar tuberosity is a hemispherical knob, while radially the head has an uneven surface for muscular attachment. On Mc. II of the right side there is no articular facet for Mc. I, while the one on the left side has a small facet near the dorsal angle. The origin of this facet may, in part, be due to injury received in this region, which is plainly shown by the rough surface of the proximal portion of the bone. The shaft is very heavy, slightly arched forward, and transversely oval in cross-section. The dorsal portion of the trochlea is not nearly as hemispherical as in *Daphœnus*, while plantarly it is divided by a prominent carina, the radial portion occupying a higher position than the ulnar, causing asymmetry of the trochlea.

[27] See fig. 19, 5, Ann. Carn. Mus., Vol. IV, p. 71, 1906.

The third metacarpal is no heavier than the second, though longer. The articular facet for the magnum slants inwardly, but the radial border is not raised as in *Daphœnodon* so as to form a transverse concavity, but instead it is very nearly plane transversely and evenly convex antero-posteriorly. On the radial side is a facet for Mc. II which is succeeded, posteriorly, by a deep sulcus, the palmar tuberosity forming its posterior border. On the ulnar side the proximal end is excavated in order to accommodate the head of Mc. IV and the articular facet for the unciform is concave due chiefly to the development of the dorso-ulnar angle of the head. The shaft is very slighty arched and transversely oval, due to the divergence of the metacarpals directly from the proximal end as in the mustelids generally. The trochlea is more symmetrical than that of Mc. II.

MEASUREMENTS.

	Mm.
Unciform, greatest antero-posterior diameter	13
Unciform, greatest transverse diameter	12
Unciform, greatest vertical diameter	15
Trapezoid, greatest antero-posterior diameter	10
Trapezoid, greatest transverse diameter	9
Trapezoid, greatest vertical diameter	6
Metacarpal I, greatest length	26
Metacarpal II, greatest length	37
Metacarpal III, greatest length	41
Median phalanx, greatest length	17

A proximal phalanx of the pollex or hallux has the proximal end much expanded, the shaft strongly arched and of considerable length, while the distal trochlea is confined principally to the plantar face. A median phalanx found with the specimen is much depressed, quite long, and does not indicate retractility of the ungual.

THE HIND LIMB.

The greater portion of the femur is preserved. The head is well rounded and sits on a long neck, as in *Meles*, *Lutra*, and *Gulo*. The pit for the ligamentum teres is located on the posterior half near the lower border. Unfortunately the great trochanter, together with the upper portion of the shaft, is lost on its external side, while internally the shaft is preserved, showing a large lesser trochanter. On the lower half of the shaft the fibular border is produced into a very prominent ridge, which is even more pronounced than in *Meles taxus* or *Gulo luscus* and terminates below in a rugose tubercle similar to that of *Canis*. The lateral development of the shaft gives it the characteristic transversely broad appearance seen in *Gulo luscus* or *Meles taxus*. The rotular trochlea is shallow and broad, the condyles have great transverse diameter and are separated by a rather shallow groove, the external condyle being quite oblique to the long axis of the bone.

The fibula is heavy and has the proximal and distal ends much expanded. The shaft sweeps gently towards the shaft of the tibia and is also gently arched in the backward direction. The facet for the astragalus is nearly plane and the posterior face has the tendinal groove and external malleolus fully as well developed as in the recent badger or otter.

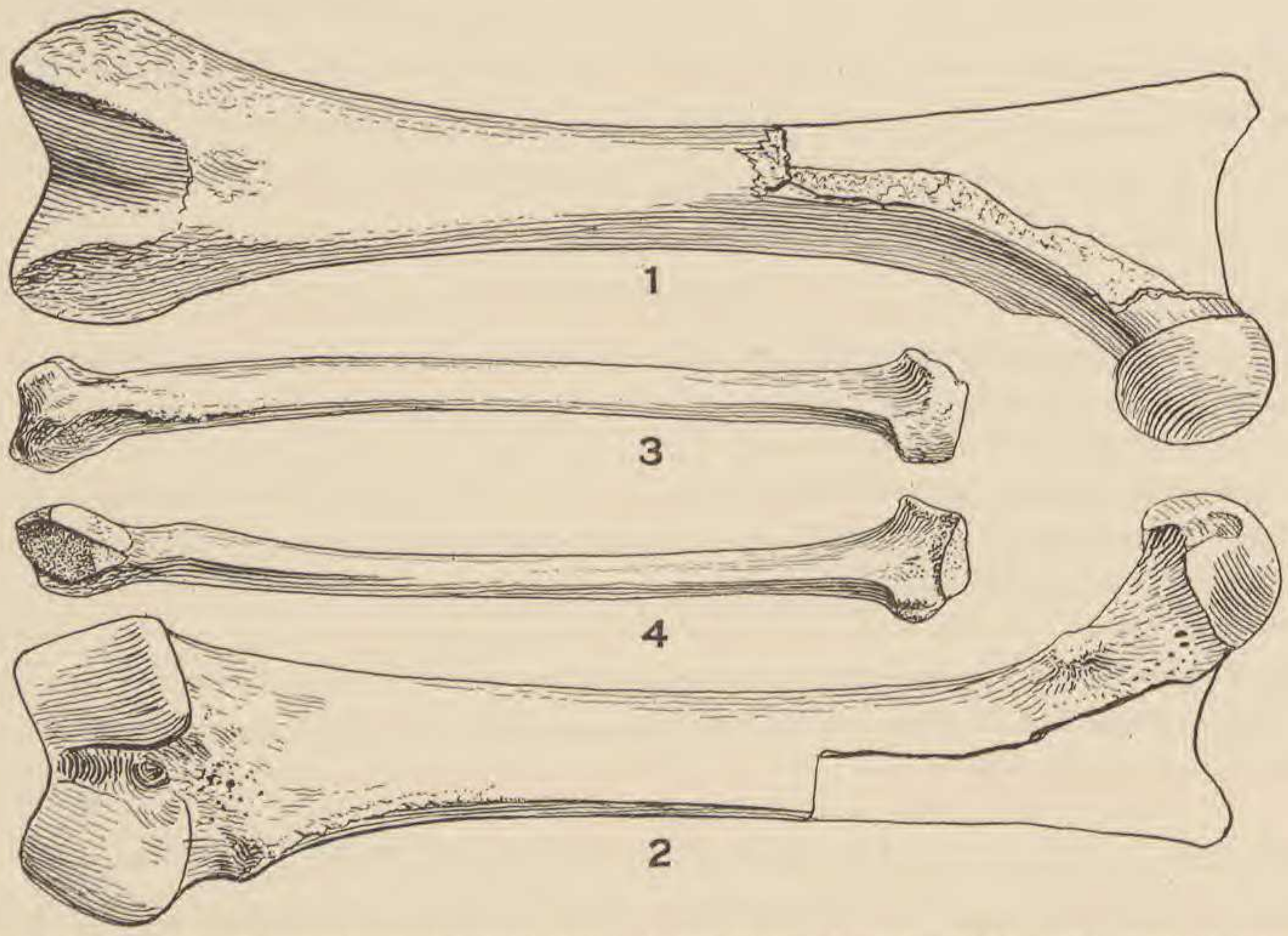

FIG. 67. Limb Bones of *Paroligobunis simplicidens*. ⅔ nat. size. 1, anterior view of femur; 2, posterior view of femur; 3, fibular view of fibula; 4, anterior view of fibula.

Both astragali are represented. In comparison with the length of the bone the trochlea is somewhat narrower than that of *Megalictis ferox*. The trochlea is very shallow and is more oblique and imperfect than in either *Meles* or *Lutra* and rather more like that of *Gulo luscus*, the internal condyle being less developed, while the external is higher than in the two recent forms first mentioned. The tibial face of the internal condyle is not interrupted by the sulcus, which is so characteristic of *Daphænodon*, but is continuous as in *Gulo* and *Meles*. The posterior limit of the trochlea, as well as its downward extent on the neck of the anterior face, is approximately in the same propor-

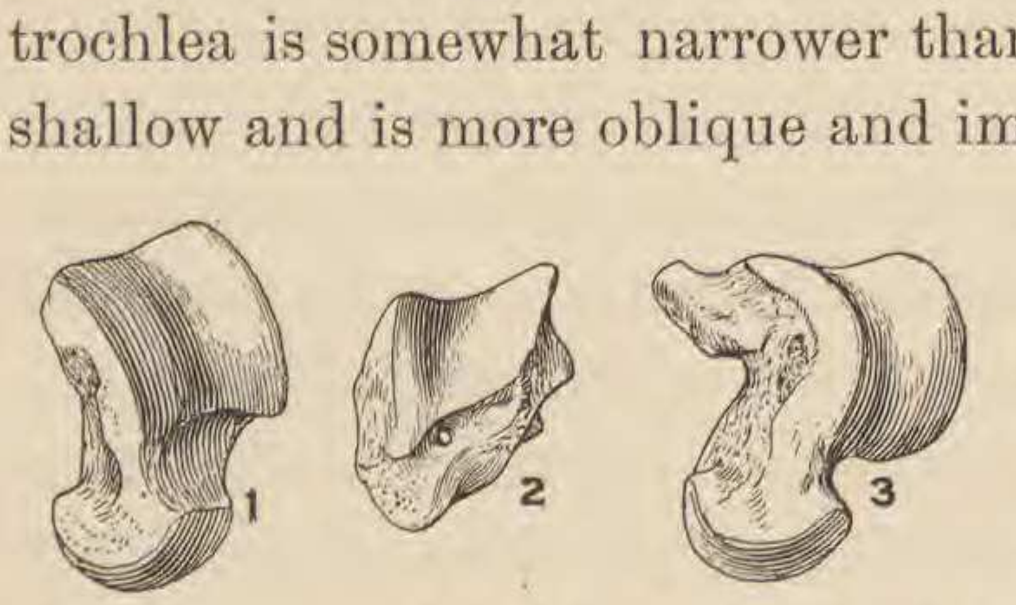

FIG. 68. Astragalus of *Paroligobunis simplicidens*. ⅔ nat. size. 1, anterior view; 2, superior view; 3, tibial view.

tion to that in the recent forms. One of the more curious features of the bone is the deep and obliquely placed sulcus, which separates the groove for the flexor muscles from the astragalar trochlea. In this groove is located the astragalar foramen (see fig. 68, 2), which pierces the bone and again appears in the groove between the internal and external facets for the calcaneum on the plantar face, as in *Meles taxus*. The neck is perhaps somewhat longer than in *Megalictis*, which again reveals a tendency towards *Gulo luscus*. The head is also expanded and convex in the same way.

A mesocuneiform which was found with the specimen and very likely belongs with it, is high and narrow when compared with *Meles*, and is apparently also slightly higher in proportion to that of *Megalictis*, but is otherwise quite like that of the latter, the tibial face possessing a large facet for the entocuneiform.

MEASUREMENTS.

	Mm.
Femur, length from head to distal end	174
Femur, transverse diameter of distal end	42
Femur, antero-posterior diameter of distal end	36
Fibula, greatest length	130
Astragalus, greatest length	33
Astragalus, greatest transverse diameter	26
Astragalus, greatest transverse diameter of trochlea	16
Mesocuneiform, greatest antero-posterior diameter	11
Mesocuneiform, greatest transverse diameter	6
Mesocuneiform, greatest vertical diameter	8

AFFINITY AND SYSTEMATIC POSITION OF *Paroligobunis*.

While some features of the limbs in *Paroligobunis simplicidens* suggest that of *Lutra; i. e.*, the oblique and limited posterior extent of the internal condyle of the femur, the backward sweep of the shaft of the fibula, the proportionate length and arrangement of the metacarpals; there are more important characters which very strongly suggest that the animal was probably fossorial rather than aquatic in his habits. The femur is much longer than the fibula and the shaft of the former bone is straight and is transversly expanded near the distal end as in *Meles*. The fibula is on the whole more nearly like that of the latter genus than that of the otter, while the astragalus strongly suggests that of *Gulo luscus* and has the astragalar foramen, a characteristic feature in *Meles*. The John Day form, *Oligobunis*, was regarded as an aberrant member of the *Canidæ* by Professor Cope, while Dr. Matthew (Bull. Amer. Mus., Vol. XXIII, p. 193, 1907) after the re-examination of the type, questions Cope's reference and transfers the genus to the *Mustelidæ*. After a comparison and careful study of the newly acquired material now in the Carnegie Museum

I fully agree with Matthew in the taxonomic position of *Oligobunis.* Furthermore it is quite evident that the present genus is closely related to the John Day form and quite likely in a direct line of descent which the generic name used implies. *Oligobunis lepidus* Matthew (*l. c.*, p. 194) is a connecting type; it is a smaller species than the John Day form, but indicates a type specialized differently from the present genus, having $M_{\overline{2}}$ very much less reduced, while $P_{\overline{1}}$ is more reduced than the same tooth in the present genus, indicating greater tendency towards the loss of one tooth and the retention of the other in *O. lepidus* than in *Paroligobunis simplicideus.* $M_{\overline{2}}$ in *O. lepidus* is one half the antero-posterior diameter of the carnassial, while that tooth in the present genus is only one third the antero-posterior diameter of the carnassial, plainly showing that in the present genus there is a more strongly marked advance toward modern forms.

Potamotherium (= *Stephanodon*) of Europe has a general resemblance to the new genus here proposed, but it is quite clear that this European form is at least generically different. In comparing the present type specimens with Dr. Schlosser's [28] figures, it is seen that $P_{\overline{1}}$ in the American form is smaller, the premolar series increases more in size, from before backward in the jaw, the metaconid of $M_{\overline{1}}$ is less developed and placed higher up on the crown, and the heel is smaller. Upon further comparison it is seen that the lower jaw is deeper and shorter in *Paroligobunis.* Of especial importance is the proportion of the hind limbs of the two genera. In *Potamotherium* the femur is shorter than the tibia, an aquatic feature, while in *Paroligobunis* the femur is longer than the tibia. The material at hand displays further comparison which may, however, be regarded as of less importance between these two genera; namely, the more strongly developed cingula and accessory tubercles of the premolars, and the external position of $P_{\overline{1}}$ in the European form, while in *Paroligobunis simplicidens* $P_{\overline{1}}$ is internal due to the reverse obliquity of $P_{\overline{2}}$ in the latter.

Paroligobunis (*Potamotherium*) *lacota* which was provisionally referred to the European genus by Matthew and Gidley [29] appears to be quite closely related to *Paroligobinus simplicidens* having apparently somewhat smaller canines and a slenderer jaw than the latter species. Dr. Matthew states (*l. c.*, p. 254) that Cope's type of *Potamotherium* (*Lutrictis*) *lycopotamicus* is lost and cannot be verified with Cope's reference, there being no illustrations of the type specimen.

Stenogale (*Potamotherium*) *robusta* Cope was based on a lower jaw containing part of the dentition and was found in the Upper Miocene near Fort Niobrara, Nebraska.

[28] Beitrage Paleontologie Osterich-Ungars und des Orients, Pl. VIII, figs. 18, 63, 64, 65, 1888.

[29] Bull. Amer. Mus. Nat. Hist., Vol. XX, p. 254, 1904.

Matthew and Gidley doubtfully referred this type to *Potamotherium.* As this American form now stands I cannot see that it is much nearer *Potamotherium* than *Stenogale* as the jaw is deeper in proportion; it is also somewhat shorter and more robust, the symphysis is lighter, the premolars are smaller and M_3 larger than in the former genus, while the latter genus has the under border of the lower jaw very much more curved fore-and-aft, the premolars are too large in proportion to the carnassial, the heel of the latter is entirely different in shape, and very much smaller, and the tubercles of the teeth are evidently sharper and higher than in the American specimen. The latter form should, I think, occupy a new generic position (~~*Brachygale*~~) Sthenictis somewhat near the *Oligobunis* phylum although the premolars are proportionally smaller than in the latter, especially in the transverse diameter. In *Paroligobunis* the jaw is proportionally shorter and heavier, the alveolar border is more curved from before backward, the premolars are more crowded, and the carnassial has apparently a shorter heel than in the new genus here proposed.

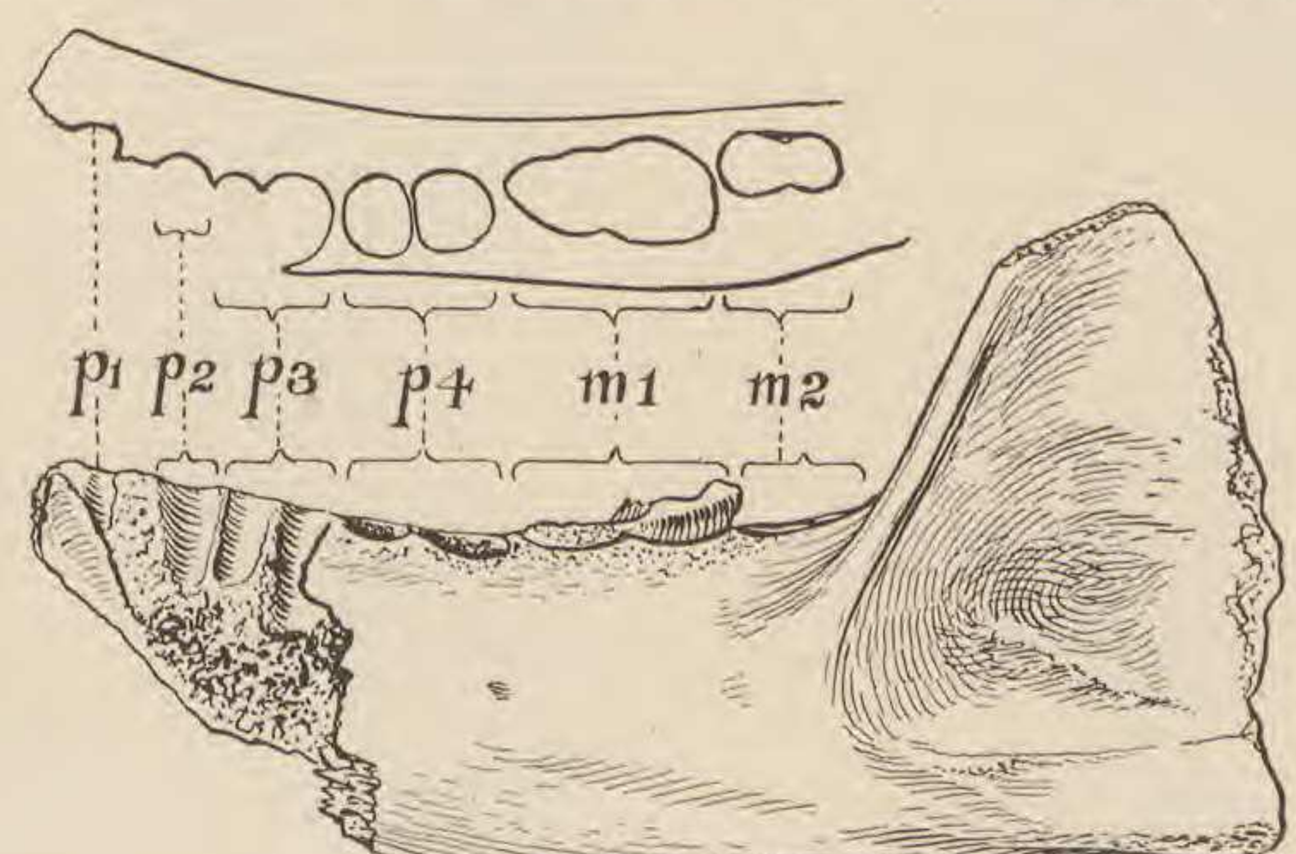

FIG. 69. Alveolar Border and External View of Jaw of *Brachypsalis pacycephalus* Cope. Nat. size. (Cope collection, No. 8544, Am. Mus. Natural History.)

Brachypsalis pachycephalus Cope was proposed (*l. c.*, p. 951) on a rather inadequate type, a left mandibular ramus, from the same locality in which *Stenogale robusta* was found. Professor Cope afterwards referred this type to *Potamotherium* of Europe, while Matthew and Gidley (*l. c.*, p. 254) accept the type as valid and distinct from *Potamotherium.* In a former paper[30] the present writer regarded *Paroligobunis* (*Brachypsalis*) *simplicidens* as possibly an ancestral form to *Brachypsalis,* a view which is no longer tenable inasmuch as the latter species has $M_{\bar{2}}$ proportionally larger, and the carnassial apparently smaller in proportion to the premolars. (Compare figs. 64 and 65 with fig. 69.)

[30] Ann. Carn. Mus., Vol. IV, p. 45, 1906.

Ælurocyon Peterson and *Megalictis* Matthew are more modified forms which, however, are apparently related to this group of the *Mustelidæ*. One of the chief generic differences between *Ælurocyon, Megalictis, Oligobunis,* and *Paroligobunis* is the presence of the metaconid on $M_{\overline{1}}$ of the two latter and the absence of it in the case of the two former genera. In *Paroligobunis* the metaconid is situated nearly as high up as the summit of the protoconid, and quite closely fused to the latter. Some of the Siwalik mustelids (*Melivoradon*) are also closely allied to this general group. I fully agree with Dr. Matthew's[31] statements that *Mellivora* and *Gulo* are the nearest living allies of *Ælurodon* and *Megalictis;* I would in fact also include *Oligobunis, Paroligobunis,* and possibly the proposed new genus ~~*Brachygale*~~ as not so very distantly related especially to *Ælurocyon* and *Megalictis.* Sthenictis

[31] Bull. Amer. Mus. Nat. Hist., Vol. XXIII, p. 204, 1907.